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Remedial Investigation Report for the

Eastern Michaud Flats Site

Part I

Executive Summary

Prepared for
FMC Corporation
J.R. Simplot Company

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Bechtel Environmental, Inc.

August 1996

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INTRODUCTION

The Executive Summary presents the scope and findings of a Remedial Investigation (RI) performed by FMC Corporation (FMC) and J.R. Simplot Company (Simplot) at the Eastern Michaud Flats (EMF) study area. The RI was performed in accordance with the Administrative Order on Consent issued by the U.S. Environmental Protection Agency (EPA) on May 30, 1991.

This Executive Summary is organized as follows:

The EMF study area was broadly defined by the EPA to include the adjacent FMC and Simplot phosphate ore processing facilities in Pocatello, Idaho; extensive portions of the Michaud Flats and Bannock Range in the vicinity of the processing facilities; the Portneuf River, which emerges from the Pocatello Valley onto Michaud Flats east of the facilities; and portions of the American Falls Reservoir. Figure ES-1 is a map and Figure ES-2 is an aerial photograph of the EMF study area.

During the RI, FMC and Simplot performed extensive sampling and analyses of surface and subsurface soils, groundwater, surface water, sediment, aquatic and terrestrial ecology and air. More than 1,500 groundwater samples were taken and more than 60,000 analyses performed. Approximately 3,600 air samples were taken and analyzed for more than 20 constituents. A detailed emissions inventory was developed for both facilities and atmospheric dispersion models were used to characterize air emissions impacts. Industrial feedstocks and potential sources of constituent releases at both facilities were characterized and soil samples were taken to a depth of as much as 70 feet at 200 locations. Outside the processing facilities, soils were sampled on a radial grid at regular intervals along 16 compass directions up to a distance of more than 3 miles. Approximately 250 surface water and sediment samples were collected and about 7,500 analyses performed. Studies of both aquatic and terrestrial ecology were performed.

The RI adequately characterizes the nature and extent of chemical constituents that may have been released from past or current practices at the FMC and Simplot processing facilities and the potential migration of these constituents within various media.

The principal findings of the RI are described below. The summary descriptions of the nature and extent of contamination are presented in terms of the relative concentrations of site-related constituents because these constituents are naturally-occurring substances that include some background component.

SOILS

- Soils containing the highest levels of facility-related constituents are confined to the FMC and Simplot operational areas. These areas exclude residential uses.
- Although concentrations of site-related constituents are primarily elevated on properties owned by FMC and Simplot, there are offsite areas with concentrations above background levels.

GROUNDWATER

- There is no migration of site-related constituents in groundwater beyond FMC- and Simplot-owned properties. No domestic or public water supply wells are downgradient of site-impacted groundwater.
- Groundwater has concentrations of site-related constituents elevated above background beneath operational areas and extending onto adjacent company-owned properties.
- The highest constituent concentrations in groundwater are limited to areas immediately downgradient of facility sources, and concentrations decrease rapidly by advective mixing with a large volume of unaffected groundwater within FMC- and Simplot-owned properties.
- Numerical groundwater flow simulations and evaluation of hydrogeologic data indicate that the groundwater underflowing the EMF facilities is captured by facility production wells or eventually discharges to the Portneuf River through baseflow or via adjacent springs. Shallow groundwater flows northward and discharges to the Portneuf River. Deeper groundwater beneath the facilities is captured onsite by the production wells or

flows upward into the shallow aquifer where the American Falls Lake Beds are absent and also discharges to the Portneuf River.

- At the points of groundwater discharge into the Portneuf River, most mean constituent concentrations in groundwater are below background levels and all are below federal drinking water standards.
- Groundwater quality on company-owned land has and will continue to improve as a result of operational changes made by FMC and Simplot that eliminate or minimize potential migration of constituents to groundwater.

SURFACE WATER AND SEDIMENTS

- Analyses of surface water and sediment samples demonstrated that the FMC and Simplot processing facilities had no significant impact on ecological receptors associated with the Portneuf River and the American Falls Reservoir.
- Cadmium was the only analyte elevated in the Portneuf River delta sediments, compared to the Snake River delta and upstream Portneuf River sediment samples.

TERRESTRIAL ECOLOGY

- Cadmium and fluoride concentrations in vegetation collected from potentially impacted areas were elevated in comparison to those from reference locations. However, these concentrations were not high enough to result in adverse impacts to ecological receptors (e.g., mule deer) that feed on these plants. Additional factors that minimize impacts include the limited biological availability of site-related constituents and the large home range of most indigenous receptors.
- Tissue analyses performed on small mammals collected from impacted areas indicated that site-related constituent concentrations were less than concentrations known to result in adverse impacts.
- Potential impacts to top predators (e.g., red-tailed hawk) that feed on small mammals were unlikely, particularly considering factors such as limited site use by these predators and limited biological availability of site-related constituents.

AIR

- Impacts to air from emissions at the facilities are primarily on the operational areas and company-owned properties and decrease with distance from the FMC and Simplot facilities.
- Air modeling results indicate that the predominant effect on ambient air quality is associated with a few sources and constituents from the FMC and Simplot facilities.

- Emissions from the operating facilities are subject to regulation under the federal Clean Air Act.
- Recent changes in facility operations have reduced emissions from some sources. Planned changes at FMC will continue to reduce emissions from some sources.

EMF FACILITY OPERATIONS

The principal feedstock at the FMC and Simplot processing facilities is phosphate rock. The rock contains apatite, a mineral containing calcium, phosphate, and fluoride. The rock also contains trace levels of arsenic, cadmium, chromium, vanadium, zinc, uranium-238 and its daughters, and other naturally occurring elements.

FMC FACILITY

The FMC facility manufactures elemental phosphorus. The phosphate rock is crushed, conveyed and formed into briquettes. A system of baghouses is used to control air emissions from the crushing and conveying system. The briquettes are calcined to remove organic materials and water, and to form heat-hardened nodules that will withstand further processing. Calciner emissions are controlled by a series of primary and secondary wet scrubbers. The nodules are cooled and blended with coke and silica before being fed to an electric arc furnace.

High furnace temperatures drive off phosphorus and carbon monoxide. Furnace off-gases pass through electrostatic precipitators to remove dust before entering the condensers, where phosphorus is condensed into a liquid. The noncondensible carbon monoxide is used as a primary fuel and any excess is flared. Molten residues are periodically withdrawn ("tapped") from the furnace and allowed to solidify into the by-product slag and co-product ferrophos. The slag, predominantly calcium silicate, is stockpiled at the facility. Ferrophos, an alloy of predominantly iron and phosphorus with vanadium, is periodically sold. Various lined surface impoundments are used to manage process wastewater.

Bannock Paving Company (BAPCO) operated a paving and aggregate handling facility on land leased from and adjacent to the FMC facility during the RI period. Activities periodically conducted at this facility included asphalt batching, coke drying, and slag and ferrophos crushing. Operations at BAPCO were discontinued on March 12, 1995, and BAPCO will vacate the property by December 31, 1995.

SIMPLOT FACILITY

The Simplot facility processes phosphate rock into phosphoric acid and other fertilizers. The phosphate rock is ground and slurried at the mine site and transported to the facility by pipeline. There it is reacted with sulfuric acid to produce phosphoric acid and by-product gypsum (calcium sulfate). Most of the sulfuric acid used in the process is produced at the facility by reacting sulfur with oxygen and absorbing the resultant sulfur trioxide in water.

The phosphoric acid is used to make various grades of fertilizer or is concentrated to produce stronger acids which are feedstocks to subsequent production lines. Phosphoric acid is reacted with ammonia, which is also produced at the facility, to produce various types of solid and liquid ammonium phosphate fertilizers. Ammonia and sulfuric acid are reacted to make crystalline ammonium sulfate. A system of baghouses and scrubbers are used to control air emissions.

The gypsum is slurried with water and transported to unlined gypsum stacks south of the processing facilities. The liquid fraction of the slurry is partially recovered by an underground collection system and reused in the process. Other process waters are collected and treated (pH adjustment) in a series of lined ponds. The treated water is nutrient rich and sold for irrigation/fertilization.

STUDY AREA CHARACTERISTICS

GEOLOGY AND HYDROGEOLOGY

The EMF study area is situated north and west of Pocatello, Idaho on the eastern portion of the Snake River plain. Volcanic bedrock, containing naturally occurring radioactive material, and coarse gravels underlay the study area. The general stratigraphy in the study area includes (from the bottom), volcanic bedrock units (rhyolite, tuffs, and some basalt), coarse volcanic and quartzitic gravels, fine-grained sediments of the American Falls Lake Bed, the Michaud gravels, Aberdeen alluvial terrace deposits (locally) and calcareous silts and clays. The latter surface sediments, which typically range in thickness from 10 to 40 feet within the facility areas, have an alkaline pH that neutralizes acidic solutions and precipitates metals.

Groundwater within the FMC and Simplot facilities flows from the Bannock Range foothills towards the north/northeast through unconsolidated sediments overlying the volcanic bedrock. Shallow and deep aquifer zones, separated by confining strata, are evident in the plant areas and to the north. Shallow groundwater flows into the valley where it mixes with the more prolific Michaud Flats and Portneuf River groundwater systems. The volume of groundwater flowing in the shallow zone from beneath the facilities is small compared to the flow within the thicker gravels in the valley. Groundwater within the deeper aquifer is captured by the facilities' production wells or continues northward where, in response to upward vertical gradients and the discontinuous presence of confining strata, it flows upward into the shallow aquifer. The shallow groundwater and a significant portion of the deeper groundwater underflowing the facilities discharges to the Portneuf River through Batiste Springs, Swanson Road Springs, and as baseflow to the River in the reach between these springs.

HYDROLOGY (SURFACE WATER)

The Portneuf River, which lies to the east and north, is the major surface water body near the facilities. To the south of Interstate 86, it is a losing stream. To the north of Interstate 86, it is a gaining stream fed by groundwater base flow and a system of springs. The Portneuf River flows into the American Falls Reservoir.

Rainwater which falls or flows onto the FMC and Simplot facilities is captured and controlled on-site such that there is no stormwater runoff from the facilities. The only surface water flowing from the EMF facilities is the permitted discharge of non-contact cooling water through the IWW ditch to the Portneuf River.

CLIMATE

The EMF study area is located in a semi-arid region, with approximately 11 inches of total precipitation during a year. Net annual evapotranspiration rate exceeds annual precipitation. Prevailing winds are from the southwest.

LAND USE

The EMF study area includes land belonging to the Fort Hall Indian Reservation, the Bureau of Land Management (BLM), Bannock and Power Counties, and portions of the cities of Pocatello and Chubbuck. Fort Hall Indian Reservation land use in the EMF Study Area is mainly agricultural. BLM land is designated as multiple use. Unincorporated land in Bannock and Power Counties is mostly agricultural with scattered residences. Pocatello and Chubbuck land in the study area is primarily zoned for residential use. Anticipated changes in study area land use are minimal.

In addition to the processing facilities, FMC and Simplot own all land (with the exception of road rights-of-way) between the facilities and Interstate 86, as well as substantial property just north of Interstate 86 and east of the facilities, including the Batiste Springs Property (acquired by FMC on January 9, 1996) and the Swanson Property (acquired by J.R. Simplot on May 31, 1996). The FMC and Simplot processing facilities and all other property owned by FMC and Simplot within the study area have or will be deed restricted to prohibit residential use.

ECOLOGY

Major terrestrial vegetation cover types and wildlife habitats in the EMF study area include agriculture, sagebrush steppe and wetland/riparian. Wildlife habitats in the vicinity of the EMF facilities include: sagebrush steppe, grassland, riparian, cliff and juniper woodland. No critical habitats for threatened or endangered species, or special habitats, occur in the study area.

The most significant aquatic habitats in the immediate vicinity of the EMF processing facilities are the Portneuf River and associated springs. Numerous commercial/industrial businesses and agricultural operations near the Portneuf River, both above and below the EMF site facilities, contribute constituents to the river.

SCOPE OF THE REMEDIAL INVESTIGATION

The RI consisted of extensive investigations of all relevant media (surface soils, groundwater, surface water and sediment, aquatic and terrestrial biota, and air) which identified sources of EMF-related constituents, potential pathways of migration and exposure, and receptors. The RI sampling programs and studies were designed and conducted to fully characterize the nature and extent of site-related constituents along these pathways within the EMF study area.

POTENTIAL SOURCE AND FACILITY SOIL INVESTIGATIONS

An investigation was conducted of areas which historic data and current FMC and Simplot plant operations indicated were most likely to have been potential sources of constituent releases or where placement, spillage or leakage of raw materials, by-products or process wastes (including phosphate ore, gypsum, slag, ferrophos, precipitator dust, phossy water and other pond or impoundment contents) could have occurred. In areas to which a sustained hydraulic head was applied (e.g., gypsum stacks, ponds), samples were generally collected throughout the unsaturated soil column. In areas to which no sustained hydraulic head was applied (e.g., solid product loadout areas), samples were generally collected to depths of 10 feet or less. Soil samples from over 200 locations and a total of more than 20 samples of industrial feedstocks, by-product and co-product and waste materials were analyzed. Samples were analyzed for more than 30 constituents of the phosphate ore, and for radioactivity, volatile and semi-volatile organics, total petroleum hydrocarbons, PCBs, nitrate, potassium, sulfate, pH, and the list of analytes under the toxicity characteristics leaching procedure (TCLP).

Samples of soils and water representing unimpacted areas (natural conditions) were also analyzed for these constituents. Results from these analyses were used as representative, or background levels. Results from analyses of processing facility samples were compared with representative concentrations to assess the nature and extent of site-related constituents.

At the FMC facility, the investigation included samples of the phosphate ore, stormwater, cooling water discharged to the IWW ditch, process water discharged to active ponds, sediments and sludges that came into contact with waste streams, and soils that may have been impacted by former or present processing and waste handling operations.

At the Simplot facility, the investigation included samples of the phosphate ore, aqueous discharges to water treatment ponds, gypsum slurry discharged to the gypsum stacks, sediment/sludge samples from ponds, treatment pond irrigation water, and facility soils that may have been impacted by former or present processing and waste handling operations.

Surface Soil Investigation

The surface soil investigation was conducted to assess the possible effects of deposition of air emissions on surface soil at portions of the EMF study area located outside the processing facilities fencelines.

The surface soil investigation consisted of the sampling and analysis of surface and two foot deep samples along 16 radials extending out from the FMC and Simplot facilities in all directions to a distance of approximately three miles. Four sample locations were selected at regular intervals within the first mile, three locations within the second mile and two locations within the third mile.

More than 140 soil samples were analyzed for 30 constituents of phosphate ore, including metals, general minerals, radioactivity and pH. Sample concentrations were compared with background soil levels and were plotted versus distance from the facilities to assess the effect of facility air emissions on surface soil. In addition, the activities of selected radioisotopes in the naturally occurring uranium-238 decay series were compared to determine if the radioisotopes were in natural secular equilibrium with uranium-238 and, in so doing, to assess the source emissions to which EMF-related effects were most likely attributable.

GEOLOGIC AND HYDROGEOLOGIC SUBSURFACE INVESTIGATIONS

Geologic and hydrogeologic investigations consisted of drilling and logging 83 borings and installation and sampling of more than 130 groundwater monitoring wells adjacent to and downgradient of suspected FMC and Simplot sources of potential groundwater contamination.

Groundwater quality was evaluated by quarterly sampling over the period of the RI. Groundwater samples were analyzed for constituents of the phosphate ore and major ions. Selected samples were also analyzed for volatile and semi-volatile organics. Quarterly water level measurements were made for mapping groundwater elevations and estimating groundwater flow patterns.

In addition, slug tests were conducted in 63 wells to estimate hydraulic conductivity of individual, saturated and coarse-grained soil intervals. Aquifer pump tests were performed in four wells to provide data for calculation of hydrogeologic parameters such as transmissivity and hydraulic conductivity, and to assess lateral and vertical hydraulic interconnections. Downhole geophysical logging (gamma and temperature) was conducted in 34 wells.

A groundwater flow model was developed to support predicted local and regional groundwater budgets and flowpaths between source and discharge areas. Model output, along with water quality data, were used to estimate the fluxes of selected groundwater constituents along groundwater flowpaths.

SURFACE WATER AND SEDIMENT INVESTIGATIONS

The surface water and sediment investigation was conducted to evaluate the potential effects of FMC and Simplot activities on the Portneuf River. The investigation consisted of sampling and analysis of springs, river water and sediments along a segment of the Portneuf River extending from approximately 6 miles upstream to approximately 5.5 miles downstream of the FMC and Simplot facilities.

Surface water samples were collected from more than 30 locations to provide samples upstream and downstream of the processing facilities, at seeps and springs that discharge to the Portneuf River, below outfalls or other anthropogenic discharges to the Portneuf River watershed. Surface water samples were collected on a quarterly basis for a year. Sediment samples were collected in the vicinity of the surface water sampling locations and in areas of quiet water where fine-grained sediments are most likely to have settled.

Surface water and sediment samples were analyzed for the constituents of phosphate ore as well as major ions. Results for samples collected downstream of the FMC and Simplot facilities were compared with upstream results and background groundwater and soil constituent concentrations to assess processing facility impacts on the Portneuf River. Estimates of solute fluxes at the point of groundwater discharge to the River were compared with solute flux estimates in the River upstream and downstream of the processing facilities to assess the contribution of selected constituents to the River relative to other sources.

In addition, stream flow rates were measured at selected Portneuf River locations and two spring discharges to develop a water budget for the River so that flow contributions from springs and streams along the River could be determined.

AQUATIC ECOLOGY INVESTIGATION

Two separate investigations were conducted to assess the potential impacts of site-related constituents detected in sediment samples. The first investigation focused on the Portneuf River delta located near the river's confluence with the American Falls reservoir. Sediment samples collected from this location were analyzed for the parameters of concern. Concentrations present in the Portneuf River sediment samples were compared to concentrations measured in samples collected from upstream locations, the nearby Snake River, and to published levels of ecological concern (LEC's). The second investigation involved the collection and analysis of additional sediment samples from the Portneuf River, both upstream and downstream from the IWW ditch. Upstream samples were compared to downstream samples and to LEC's. In addition, laboratory toxicity tests were conducted to assess whether constituents present in these samples could adversely impact aquatic ecological receptors.

TERRESTRIAL ECOLOGY INVESTIGATION

The terrestrial ecology investigation consisted of sampling and analysis of co-located soils, vegetation and small mammals in the dominant native upland terrestrial ecosystem – sagebrush steppe – and in the riparian habitat bordering the Portneuf River. Sample locations ranged from 1 to 2 miles southwest of the FMC and Simplot facilities to 15 miles to the north/northeast. The samples were analyzed for cadmium, fluoride, and zinc.

Results for samples collected in areas potentially affected by the EMF facilities were compared with results for samples from reference locations. The biological availability of soil constituents was evaluated by determining tissue concentrations of constituents present in vegetation and small animals collected from the impacted area.

AIR INVESTIGATION

The air investigation consisted of an air monitoring investigation and air modeling. The air monitoring investigation consisted of sampling and analysis of ambient air at seven locations in the vicinity of the FMC and Simplot facilities for a period of 13 months. Over 3,600 samples of the particulate matter present in air were collected to characterize air quality. Three monitoring stations were located along or near the fenceline of the industrial operations areas of the facilities. Another three were placed several miles from the facilities near residential areas. The background sampling station was over 12 miles southwest of the facilities and in the prevailing upwind direction.

flow. Impacted groundwater does not flow east of the Portneuf River. Regional groundwater flow patterns preclude westward and northward flow of site-impacted groundwater.

- There is no migration of site-related constituents to groundwater beyond FMC- and Simplot-owned properties. No domestic or public water supply wells are downgradient of site-impacted groundwater.
- Groundwater used at FMC for drinking water purposes meets federal drinking water standards.

SURFACE WATER/SEDIMENT AND AQUATIC ECOLOGY

The EMF facilities have had no measurable effect on the Portneuf River, with two exceptions: (1) there was a slight, localized increase in sulfate concentrations potentially related to influent site-affected groundwater, and (2) sediments collected at the FMC outfall were found to contain traces of phosphate ore and precipitator dust.

Specific surface water and sediment findings are as follows:

- The EMF facilities have not caused adverse impacts on surface water quality. Although surface water samples collected downstream from the facilities contain higher concentrations of sulfate, nitrate, and total phosphorus than do samples collected from upstream locations, this difference in water quality is primarily a function of non-site-related contributions (sewer treatment plant, fish farms and agricultural runoff) and regional groundwater discharge to the River. Downstream from the two facilities, the river gains water from groundwater discharges. These groundwater discharges contain higher concentrations of sulfate, nitrate and phosphate than does the Portneuf River.
- Impacted groundwater discharges at Batiste and Swanson Road springs as well as by baseflow to the Portneuf River. The average concentrations of facility-related chemicals in groundwater discharging at Batiste and Swanson Road Springs were not significantly above background groundwater levels. None of the constituents were identified at elevated levels in samples collected immediately downstream of Batiste or Swanson Road Spring.
- Groundwater models and results of analyses performed on groundwater samples predicted that potential impacts of the FMC and Simplot facilities on surface water quality were minimal. Analysis of surface water samples collected from the Portneuf River confirmed the model prediction. While the EMF facilities and other sources contribute to the elevated surface water concentrations of sulfate, nitrate, and phosphate, no adverse impacts to ecological receptors have been noted in the river.

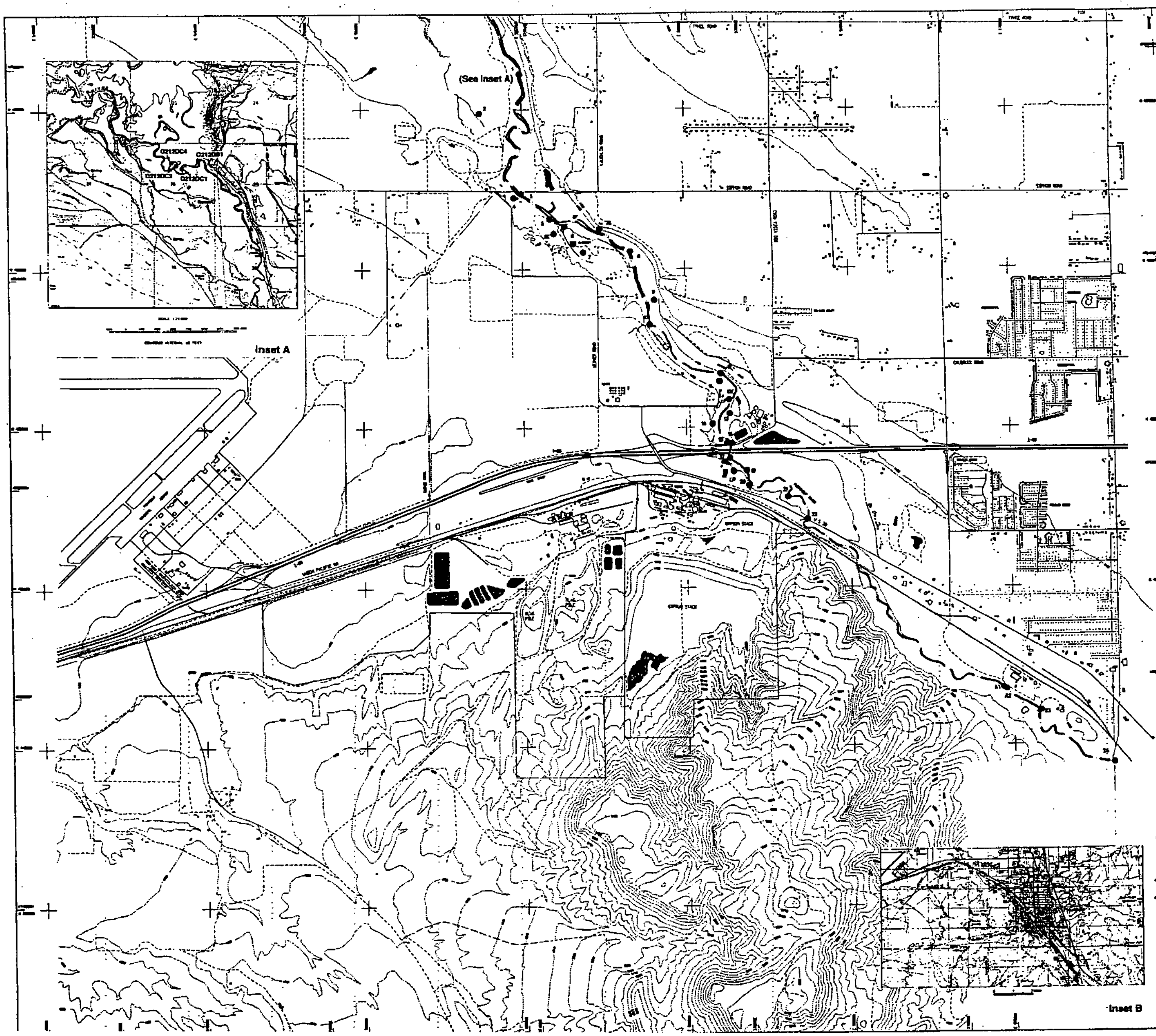
- Cadmium was the only analyte detected at an elevated concentration in a sediment sample collected in the immediate vicinity of the IWW ditch outfall. The sampling location immediately downstream of the outfall sampling location did not contain elevated cadmium concentrations. In addition, bioassays conducted on sediment samples collected near the outfall revealed that the sediments were not toxic to test benthic organisms.
- Cadmium was the only analyte elevated in Portneuf River delta sediments, compared to both Snake River delta and upstream Portneuf River sediment samples. However, the Portneuf River delta sediment cadmium concentrations were below levels of ecological concern established by sediment bioassays, were below the concentration of a sediment sample of the IWW ditch outfall, and were not found to be toxic.

TERRESTRIAL ECOLOGY

An extensive terrestrial ecological investigation was conducted to characterize potential impacts of site-related constituents. The site-specific terrestrial ecological investigation demonstrated that concentrations of site-related constituents present in vegetation were not likely to result in adverse impacts to animals feeding on plants in the impacted area. In addition, tissue analyses indicated that small mammals were not accumulating constituents in concentrations that would result in adverse impacts to these members of the terrestrial community. The results indicated that exposures to predators that feed on these mammals are also limited.

Specific terrestrial ecology findings are as follows:

- Concentrations of cadmium, fluoride, and zinc in soil samples collected from the impacted areas were generally elevated compared to concentrations present in soils collected from reference locations.
- Cadmium and fluoride concentrations in vegetation collected from potentially impacted areas were elevated in comparison to those from reference locations. However, these concentrations were not high enough to result in adverse impacts to ecological receptors (e.g., the mule deer) that feed on these plants. Additional factors that minimize impacts are the limited biological availability of site-related constituents and the large home range of most indigenous receptors.
- Measured values for constituents present in vegetation collected from impacted areas were significantly lower than general predicted plant uptake values from a national survey, indicating that the use of general values will result in an overestimation of ecological exposures in the EMF study area.



NOTE:

Numbered sample locations either preceded or followed by a letter are supplemental locations where samples were taken after the initial sampling round.

Inset A: Additional sediment sampling locations (12/92). Source: USGS Michaud Quadrangle, Idaho, 7.5 minute series (topographic), 1974.

Inset B: Sampling location 25. Source: USGS Pocatello, Idaho, topographic map 1984.

● Sample Locations

BECHTEL ENVIRONMENTAL, INC

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Surface Water and Sediment Sampling Locations

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Introduction

Part II of the Remedial Investigation (RI) report for the Eastern Michaud Flats (EMF) study area, Surface and Subsurface Characterizations, is a compilation and interpretation of physical and chemical surface and subsurface data collected during various phases of the RI as well as data reported in previous investigations. The EMF study area is defined as the sum of all areas in the vicinity of the EMF facilities investigated during the RI and has no clearly delineated boundaries.

Air monitoring and modeling studies are described in RI Report Part III. An air monitoring summary is, however, presented in Section 4.7 of Part II.

Part II of the RI Report augments "Preliminary Site Characterization Summary for the Eastern Michaud Flats Site" (PSCS) (Bechtel, 1994a). Responses to EPA comments on the PSCS have been incorporated into Part II. Point-by-Point responses to the EPA comments are provided in Appendix T.

Report Objectives

The objectives of Part II of the RI report are to:

- Present and interpret physical data collected during the field surface and subsurface investigations for use in describing the potential pathways for migration of constituents of potential concern.
- Describe the nature and extent of constituents of potential concern in groundwater, surface water, soils, and sediments using the results of laboratory analyses of environmental samples collected during RI field investigations.
- Describe the fate and transport of constituents of potential concern in the environmental media listed above.
- Furnish data for use in the baseline risk assessment to be performed by EPA and its contractor.
- Furnish data for use in identifying potential remedial action objectives.

- Provide a technical foundation and source of information for feasibility studies of potential remedial action alternatives.

Information on the original scope and objectives of the RI is available in previously published documents: RI/FS Work Plan (Bechtel, 1992b), the Phase II Work Plan (Bechtel, 1993c), "Response to EPA Comments on Phase II Site Investigation Plan," by FMC and Simplot (dated August 9, 1993), and the "Ecological Assessment Work Plan" (E&E, 1994).

The RI was performed in accordance with the Administrative Order of Consent (AOC) for Remedial Investigation/Feasibility Study (RI/FS) for the EMF site, issued by the U.S. Environmental Protection Agency (EPA) on May 30, 1991, and entered into by FMC Corporation (FMC) and J.R. Simplot Company (Simplot). These two EMF facilities and surrounding FMC and Simplot properties, hereinafter referred to as EMF properties, encompass approximately 2,450 acres in Power and Bannock counties (Figure 1-1). An aerial photograph of the facilities and surrounding area with the American Falls Reservoir in the background is shown in Figure 1-2. Properties owned by FMC Corporation and the J. R. Simplot Company and their dates of acquisition are shown in Figure 1-3. These properties were owned by each company at the beginning of the remedial investigation in 1992, with two exceptions: the Batiste Spring property and the Swanson property. The Batiste Spring property is a 23-acre parcel purchased from the Union Pacific Railroad by FMC on January 9, 1996, while the Swanson property was purchased by the J.R. Simplot Company on May 31, 1996. FMC is also a treatment, storage, and disposal facility (EPA Identification Number IDD 070929518) under the Resource Conservation and Recovery Act (RCRA).

Report Contents and Organization

The organization of Part II of the RI report is based on the suggested RI report format provided in the EPA document "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988d).

Section 1 includes descriptions of the FMC and Simplot facility operations. In addition, it summarizes previous environmental investigations with potential relevance to the EMF facilities.

Section 2 provides summaries of field activities, data collection procedures, and analytical methods used during the various investigations and phases of the RI. The information is presented relative to the following topics:

- Potential source and facility soils

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- Surface soils
- Geology and subsurface soils
- Groundwater
- Surface water and sediments
- Land use/demography
- Ecology

Section 3 describes the physical characteristics of the EMF study area based on the results of the investigations conducted for the RI, and includes information on the following:

- Regional hydrology and geology
- Drainage and surface water hydrology
- Site geology
- Site hydrogeology
- Climate
- Demography and land use
- Ecology

Section 4 describes the nature and extent of chemical constituents which appear to be associated with the EMF facilities, hereinafter referred to as "EMF-related" chemicals. The discussion is based on the results of the various phases of investigation conducted for the RI, relative to the following topics:

- Potential sources/facility soils
- Surface soils (beyond facility boundaries)
- Groundwater
- Surface water and sediments
- Aquatic ecology
- Terrestrial ecology

- Air monitoring

Section 5 describes the fate and transport of chemical constituents within the various environmental media described in Section 4.

Section Contents and Organization

The remainder of Section 1 summarizes FMC and Simplot facility operations and previous environmental studies of, or in the vicinity of, the facilities. Specifically, Section 1.1 discusses the FMC facility manufacturing, by-product handling, and waste management operations, and Section 1.2 discusses the same for the Simplot facility. Previous investigations are summarized in Section 1.3.

1.1 FMC SITE HISTORY

The FMC Elemental Phosphorus Plant is located approximately 3 miles (4.8 km) northwest of Pocatello, Idaho, and 1 mile (1.6 km) southwest of the Portneuf River, a tributary of the Snake River. The facility covers an estimated 1,189 acres and adjoins the western boundary of the Simplot Don Plant. The facility plan of the FMC plant is shown in Figure 1.1-1. Access to FMC is provided by Interstate Highway 86 (I-86) and U.S. Highway 30.

1.1.1 SUMMARY OF FMC OPERATIONS

Three types of operations are conducted at the FMC facility: manufacture of elemental phosphorus from ore; management of by-products generated during phosphorus production; and management of wastes generated as a result of the above operations. The following is a brief overview of these operations.

The FMC plant produces elemental phosphorus from phosphate-bearing shale ore mined regionally. At present, the ore is shipped to FMC via the Union Pacific Railroad (UPRR) during the summer months. Since ore cannot be shipped during the winter months, it is stockpiled on the facility property to ensure a steady supply for processing throughout the year. The estimated quantity of ore processed at the plant is about 1.5 million tons per year.

Elemental phosphorus production operations at the facility have changed little since plant operations began in 1949. Ore from the stockpiles is sized, briquetted, calcined, and proportioned for feeding into any one of the four electric arc furnaces. The furnace reaction yields gaseous elemental phosphorus in addition to other by-products. The elemental phosphorus is subsequently condensed to a liquid state and stored in tanks prior to shipment offsite as product. Elemental phosphorus will burn upon contact with air. Therefore, to prevent oxidation, the condensed product is covered with water from the time it is generated through its transport off the site.

The primary products are calcium silicate slag and carbon monoxide. Ferrophos is a minor coproduct. By-product and coproduct management generally involves cooling the by-products and either storing them in stockpiles at the site (slag and ferrophos) or reuse in elemental phosphorus production operations (carbon monoxide).

The primary waste stream generated at FMC is wastewater, which contains various suspended and dissolved solids as well as minor amounts of elemental phosphorus. Additional wastes generated are associated with scrubbers and filters located in the furnace and calcining areas and include scrubber blowdowns and used filter media. Liquid wastes are managed in a series of surface impoundments. Examples of other types of solid waste management units include landfills, treatment units, and waste storage areas. Because of the age of the facility, most of the waste management units identified are inactive and no longer receive wastes.

Sections 1.1.2 through 1.1.3 discuss the FMC plant product manufacturing, by-product handling, and waste management operations.

1.1.2 ELEMENTAL PHOSPHORUS PRODUCTION

Elemental phosphorus manufacturing operations conducted at the FMC facility are discussed below. A general process flow diagram is included as Figure 1.1-2.

Stockpiled ore received via railcars is prepared for use as furnace feed material, by first blending, reclaiming, screening, crushing, and sorting, thus providing a consistent size for forming briquettes. The sized ore is formed into charcoal-sized briquettes using continuous roll presses. The briquettes are subsequently heat-hardened at two continuous-grate calciners to drive off any remaining moisture and organic constituents that may be present.

The calcining process generates an off-gas stream containing particulates and naturally occurring radionuclides; these constituents are removed by a series of primary and secondary wet scrubbers located in the calcining area. Calcined briquettes are cooled and transferred to the proportioning building, where they are blended with predetermined ratios of silica and coke.

The furnace operation is considered the central processing step for the production of elemental phosphorus. Furnace burden is gravity fed to the designated furnace; each furnace is equipped with three graphite electrodes, and operates at temperatures ranging from 1450 to 1600°C with a typical off-gas temperature of 500°C. The ensuing reaction yields gaseous elemental phosphorus as well as other by-products.

These gases are cleaned of entrained dust in a two-stage electrostatic precipitator process, and then condensed in primary and secondary water spray condensers to recover the elemental phosphorus. The molten phosphorus is collected in sumps and either offloaded at the product loading area (phos dock) onto rail cars for shipment, or loaded into tanks for interim storage.

1.1.3 Waste and By-Product Management Practices

Phosphorus production operations at FMC require the use of large quantities of water. To prevent oxidation, elemental phosphorus is stored under water, as are wastes containing elemental phosphorus. The characteristics of elemental phosphorus also require that extensive supplies of fire water be maintained at the facility site. Additionally, water is required for other purposes, including use as makeup water to wet scrubbers, washdown in the furnace building, cold water spray on condensers, and slurrying of precipitator dust from electrostatic precipitators.

Water consumed at the plant is obtained onsite from either the production wells (fresh water) or various surface impoundments or ponds (recycled water). Surface impoundments are crucial for maintenance of the overall water management system at the plant for the following reasons:

- Solids must be covered with water to prevent oxidation and to allow for settling.
- The use of recycled water for process operations requires a high quality of water (i.e., low solids content).
- The amount of wastewater produced exceeds the amount of recycled water required for process operations. In addition to providing for settling of solids, surface impoundments provide the requisite evaporative surface area.

Wastewater has been a significant waste stream generated by FMC during its operational history. Most of the wastewaster has been managed in surface impoundments.

Other wastes at the plant include slag, pond solids dredged from the surface impoundments, waste filter elements, laboratory wastes, and small quantities of wastes generated as a result of ancillary facility operations. In general, the wastes have been stored at various waste storage areas, shipped offsite, or disposed of at the onsite landfills.

Coproduct ferrophos is crushed and sold for its enriched metal value. Carbon monoxide gas is used for its fuel value in the calciners or is flared.

The characteristics, source, and disposition of the FMC waste streams and by-products are summarized in Section 1.1.3.1 below. Associated waste or by-product management facilities are described in Section 1.1.3.2.

1.1.3.1 Waste or By-Product Description

Waste streams at the FMC facility consist primarily of wastewater. These waste streams and other facility wastes or by-products are described below.

Wastewater

Wastewater generated at the facility can be categorized as phossy water, precipitator slurry, scrubber blowdown, or noncontact cooling water.

Phossy Water. Phossy water is defined as any water that has come into contact with elemental phosphorus throughout the process. In the past, all phossy water has been considered hazardous (under RCRA) and has been managed through a series of ponds at the facility. These ponds are the slag pit sump, Pond 8S, the lined Ponds 15S and 16S, and the lined Phase IV ponds (Ponds 11S, 12S, 13S, and 14S).

Phossy water was recharacterized in 1993 based on TCLP analytical results, cadmium being the critical analyte. September 1993 was a RCRA regulatory deadline requiring that FMC's Phase IV ponds stop receipt of hazardous waste. FMC personnel did extensive sampling and TCLP analyses of waste streams going to onsite surface impoundments as part of an effort to insure that the Phase IV ponds would no longer receive phossy water exceeding TCLP limits.

The 1993 TCLP analytical results showed FMC personnel that cadmium sources resulting in exceedences of TCLP limits were identifiable episodic operations. This finding allowed FMC to segregate sources that had the potential to generate phossy water exceeding TCLP limits from those sources that generated phossy water well below the TCLP limits.

Nonhazardous phossy water is directed to the Phase IV ponds while phossy water containing elevated cadmium levels from certain operations is directed to Pond 16S (a pond built to meet RCRA Minimum Technology Standards). These data were submitted to the EPA Region 10 RCRA Program as part of their review of FMC's pond status in late 1993.

As of September 1, 1993, FMC recharacterized sources of phossy water based on extensive sampling, allowing FMC to segregate the phossy water stream into nonhazardous phossy water, which is directed to the Phase IV ponds and hazardous phossy water, which is directed to Pond 16S, a pond meeting RCRA requirements for hazardous wastes.

Precipitator Slurry. This waste stream consists of slurried precipitator dust from the furnace electrostatic precipitator operations. From January 23, 1990, to January 22, 1994, the waste was pumped to the lined Pond 8E, an interim storage pond designed to hold 1 year's supply of slurried dust. Precipitator slurry was dredged from Pond 8E to the lined Pond 9E for solids settlement. Decant from Pond 9E was formerly received by lined Pond 15S and currently by lined Pond 16S, as part of the facility's integrated water management system.

Scrubber Blowdown. The blowdown from the calciner and the Medusa scrubbers is discharged to the onsite wastewater treatment unit for pH adjustment. The treated blowdown is clarified in the lined calciner ponds (Ponds 1C, 2C, 3C, and 4C) before being recycled back to the plant as makeup water for the calciner scrubbers.

Noncontact Cooling Water. Noncontact cooling water consists primarily of fresh water, and is used for activities such as secondary cooling loops, furnace cooling, and calciner water beams. This water is typically sent to the industrial wastewater (IWW) basin for cooling; from there it is discharged to Portneuf River via the IWW ditch (NPDES Permit ID-000022-1). Water from the IWW basin can also be sent back to the plant for use as recycled water.

By-products and Coproducts

By-products at FMC are generated during reactions within the electric arc furnaces and consist of carbon monoxide gas and calcium silicate slag, also referred to as slag. The coproduct ferrophos is also generated in the furnaces.

Carbon Monoxide. Carbon monoxide gas is passed through the secondary condenser for further phosphorus recovery. The gas is then either used as primary fuel for the calcining process or flared.

Slag and Ferrophos. The molten material that remains in the furnaces during elemental phosphorus production consists of slag and ferrophos. Each of these materials is tapped from the furnaces several times per day. The tapping process is performed in a hood-type arrangement to allow for collection of any fumes generated during the tapping process. These fumes first pass through a Medusa wet venturi action scrubber, and then through Andersen filter dry scrubbers.

The molten slag flows out of the tap holes and into a slag pit, where it is sprayed with water for cooling and fracturing. The cooled, vitrified slag is loaded into haul trucks for placement in the slag piles. Historically, this material has been used extensively for paving and as fill material on the facility property and in the City of Pocatello.

Analyses of slag characteristics have resulted in the following conclusions:

- The material contains detectable levels of aluminum, arsenic, boron, cadmium, calcium, chromium, fluoride, total phosphorus, sodium, potassium, vanadium, and zinc.
- Slag passes the Toxicity Characteristic Leaching Procedure (TCLP) test prescribed by RCRA, as codified in 40 CFR 261 (i.e., concentrations of specific constituents in slag, such as cadmium and arsenic, do not exceed hazardous waste threshold concentrations for corresponding constituents specified by RCRA).
- Migration of constituents from this material into the subsurface is not considered to be of concern.

The coproduct ferrophos is a phosphorus and iron alloy, which also contains detectable levels of chromium, nickel, silver, and vanadium. It is collected in sand molds and cooled in the furnace building. The ferrophos is transferred to ferrophos piles located on the site, and subsequently sold.

Andersen Filter Media (AFM) Wastes

AFM is used in scrubbers in the furnace tapping and phos dock fume treatment operations. In 1990, when the plant became subject to RCRA, the AFM was found to contain arsenic and cadmium. Since 1990, the AFM has been sent to an offsite RCRA-permitted landfill. In 1991, FMC began treatment of the media through a washing unit. The rinse waters generated are subsequently treated along with the calciner and Medusa scrubber blowdowns at the wastewater treatment unit. Used AFM is stored at the facility until a full shipment can be sent offsite for disposal. Prior to 1990, AFM was disposed of at the onsite landfill.

Miscellaneous Wastes

Other wastes generated at FMC include small quantities of waste paint, spent solvents (from degreasing and laboratory operations), office trash, asbestos waste, and used transformer oil. Office trash, asbestos waste, and used Andersen filter media (prior to regulation) have been disposed of at the onsite landfill. Transformer oil has been shipped to various handlers through the years, and is currently being shipped to Aptus. Spent laboratory and degreasing solvents have been shipped offsite to FMC-approved disposers.

A categorization of the potential source materials handled at the FMC plant is indicated below:

FMC POTENTIAL SOURCE MATERIALS	CLASSIFICATION
• shale ore	• feedstock
• slag	• by-product
• ferrophos	• product
• phossy liquids	• waste
• precipitator slurry	• waste
• coke	• feedstock
• calciner fines	• by-product
• silica	• feedstock
• office trash	• waste
• phosphorus	• product

Air Emissions

Air emissions from the FMC facility are regulated by the state of Idaho (Air Permit 1260-00050). The FMC facility permit covers the shale handling/ crushing operations, the calciners, various material handling systems, the four electric arc furnaces, the electrostatic precipitators, the carbon monoxide flaring system, and the phos dock. Parameters regulated include phosphorus, sulfur (contained in fuel), and particulate emissions.

1.1.3.2 Waste or By-Product Management Facilities

This section briefly describes the waste management facilities and potential source areas at the FMC facility. The locations of these waste management facilities are shown in Figure 1.1-1. Some of these facilities are RCRA waste management units. Descriptions of waste management

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units are provided in the RCRA Part B permit application submitted to the EPA on March 1, 1991.

Surface Impoundments

Currently, the various wastewater streams are managed in the following 11 lined ponds:

- Phase IV ponds (Ponds 11S, 12S, 13S, and 14S) — nonhazardous phossy water
- Precipitator ponds (Ponds 8E and 9E) — precipitator slurry. These ponds will manage non-hazardous precipitator slurry in 1995.
- Pond 16S — hazardous phossy water, precipitator slurry
- Calciner ponds (Ponds 1C, 2C, 3C, and 4C) — treated stream from wastewater treatment.

In 1993, FMC submitted closure plans for three surface impoundments: Ponds 15S and 8S, and the slag pit sump. All of these units are currently inactive. Ponds 8S and 15S are receiving only nonhazardous water for level control. Also in 1993, FMC's RCRA Part B permit application was revised to reflect the change in service to nonhazardous operations and delay of closure for the Phase IV ponds.

In addition, at least 24 former ponds have been identified as having been used to manage wastewater on the FMC facility property; they are as follows:

- Old settlement ponds (Ponds 00S, 0S, 1S, 2S, 3S, 4S, 5S, 6S, 7S, 9S, and 10S)
- Old evaporation ponds (Ponds 1E, 2E, 3E, 4E, 5E, 6E, and 7E)
- Kiln scrubber and overflow ponds (consisting of three kiln scrubber ponds which overflowed to one overflow pond)
- Former calciner ponds (old Ponds 1C and 2C)

These ponds were removed from service. Several of the active surface impoundments were later constructed over these former ponds as shown in Figure 1.1-1. Determination of the extent of these former ponds is based on examination of aerial photographs since design and construction records for these ponds are not available, and only approximate dimensions and capacities, and limited information on associated structures (if any) are known.

IWW Basin and Ditch

The IWW basin, used to cool noncontact cooling water, is 131 feet (40 m) by 102 feet (31 m), and 4 feet 6 inches deep (1.4 m). Wastewater from this unit is either sent back to the plant for reuse, or discharged to the Portneuf River via the IWW ditch that exits the facility at the northeast corner of the property (Figure 1.1-1). The ditch is approximately 1,700 feet (518 m) long, and averages about 6 feet (1.8 m) in width and 3 feet (0.9 m) in depth. Both the basin and the ditch are unlined.

Landfills

The FMC facility contains two landfills, only one of which is currently active. The inactive (old) landfill was removed from service and covered with slag in 1980, upon construction of the new landfill. Reportedly, the old landfill received used AFM, facility trash and debris, asbestos wastes, and fluid bed drier wastes. The new landfill has received used AFM, office trash, and asbestos wastes.

1.2 SIMPLOT SITE HISTORY

The Simplot Don Plant, approximately 2.5 miles (4 km) west of Pocatello, Idaho, began production of single superphosphate fertilizer in 1944. Phosphoric acid production began in 1954. The facility covers approximately 745 acres and adjoins the eastern property boundary of the FMC facility. The Simplot facility lies approximately 500 feet (150 m) southwest of the Portneuf River. A facility plan of the Simplot plant is provided in Figure 1.2-1. Access to Simplot is provided by I-86 and U.S. Highway 30.

1.2.1 SUMMARY OF SIMPLOT OPERATIONS

The Simplot plant produces phosphoric acid from phosphate ore using a wet (aqueous) process. Phosphate ore was formerly transported from the Gay, Conda, and Smoky Canyon mines to the plant via railcar. As of September 1991, the Simplot plant began receiving phosphate ore through a slurry pipeline solely from the Smoky Canyon mine.

In preparation for transport, the phosphate ore is crushed and beneficiated (physically washed) at the Smoky Canyon phosphate mining/processing plant. Fine and coarse materials generated from the crushing process are separated in sequence by classifiers and a hydroclone system. The beneficiation process yields a 31-percent equivalent phosphorus pentoxide (P_2O_5) concentrate suitable for production of phosphoric acid. The slurry is transported to the Simplot facility through the buried pipeline.

Upon arrival at the plant, the slurried phosphate ore is thickened to approximately 70 percent solids content before being stored in agitated tanks. It is pumped directly into the phosphoric acid reactor from the storage tanks. The phosphoric acid is further processed into a variety of solid and liquid fertilizers. The plant produces 12 principal products, including five grades of solid fertilizers and four grades of liquid fertilizers.

The plant is an integration of several different processing units, each unit producing either an intermediate or a final product. A block flow diagram summarizing Simplot's operational processes is provided in Figure 1.2-2. Summaries of each plant and its respective products are presented below.

1.2.1.1 Phosphoric Acid Plant

The ground ore is digested for several hours with sulfuric acid to produce phosphoric acid (26- to 30-percent equivalent P_2O_5) and a hydrated calcium sulfate by-product (gypsum). Phosphoric acid process descriptions refer to equivalent P_2O_5 levels at each stage of production because the acid is sold according to its equivalent P_2O_5 content. The phosphoric acid/gypsum slurry is pumped to a vacuum filtration system for separation of the gypsum solids from the phosphoric acid liquid. The phosphoric acid is then used to make the various grades of fertilizers either as is or after concentration to 44- to 52-percent equivalent P_2O_5 by vacuum evaporation. The gypsum slurry is thickened to 25- to 40-percent solids to minimize water consumption, and is then pumped to the gypsum stack.

1.2.1.2 Sulfuric Acid Plant

Simplot produces sulfuric acid (H_2SO_4) used primarily for the production of phosphoric acid. Liquid sulfur is burned with air to form sulfur dioxide (SO_2), which is then reacted with oxygen over a catalyst to form sulfur trioxide (SO_3). The SO_3 is absorbed in water, in the presence of 98-percent sulfuric acid, to form H_2SO_4.

1.2.1.3 Ammonium Phosphate Plants

Several grades of solid fertilizers are produced in the ammonium phosphate (ammo-phos) plants. Phosphoric acid, sulfuric acid, and ammonia are mixed in a reactor to form a slurry. The slurry is combined with recycled ammo-phos product in a granulator. The slurry coats the recycled particles, forming a larger particle of ammo-phos. The granulated product is then dried and screened, with the intermediate-sized particles being the final product. The oversized material is crushed and recycled with the fines.

1.2.1.4 Ammonium Sulfate Plant

Ammonium sulfate is a solid fertilizer produced by the reaction of ammonia and sulfuric acid under vacuum. The vacuum crystallization reaction forms product crystals which are separated from liquid by centrifuging. The crystals are dried and stored as product, and the liquid is recycled. A major source of ammonium sulfate to the plant is an ammonium solution from the Amm SO_x scrubber on the #3 sulfuric acid plant.

1.2.1.5 Triple Superphosphate Plant

Triple superphosphate is a solid fertilizer currently produced by a patented process. The resulting acidulated solid is granulated, dried, and screened. Dicalcium phosphate is also manufactured at the plant for use as an animal feed supplement.

1.2.1.6 Super Acid Plant

Super phosphoric acid (68-percent equivalent P_2O_5) is produced by concentrating phosphoric acid through vacuum evaporation. The water vapor that is removed in the super acid plant is condensed and returned to the phosphoric acid plant for reuse.

1.2.1.7 Liquid Fertilizer Plant

Liquid ammo-phos is produced by reacting ammonia, water, and super phosphoric acid.

1.2.1.8 UAN-32 Plant

UAN-32 is a liquid solution of urea and ammonium nitrate used as a fertilizer. It is produced by combining ammonium nitrate and urea solution to produce a 32-percent nitrogen solution. Nitric acid is also produced at the facility, by the conversion of ammonia into nitric oxides and subsequent solution in water. The ammonium nitrate is produced by the reaction of nitric acid and ammonia. Urea is produced by a reaction between carbon dioxide and ammonia in an autoclave.

1.2.1.9 Ammonia Plant

The ammonia used in plant processes is produced at the facility using natural gas, steam, and air. Steam and natural gas are passed over a catalyst at high temperature and pressure to form hydrogen and carbon monoxide. Air is mixed with this gas stream, and the carbon monoxide is subsequently converted to carbon dioxide which is absorbed in a recirculating UCARSOL© solution. Unabsorbed carbon dioxide is reacted with hydrogen in a methanator forming methane and water. The major process gas stream now contains hydrogen, nitrogen, and water. The water is removed, and the process gas stream is compressed and reacted over a catalyst to form ammonia. The absorbed carbon dioxide is recovered and used in the production of urea or sold to Airco.

1.2.2 WASTE OR BY-PRODUCT DESCRIPTION

The main waste or by-product streams generated at the Simplot facility are the gypsum solids and liquids generated in phosphoric acid production. Other waste streams generated at the site include waste oils and various solvents. The Simplot facility also treats noncontact water in a series of three water treatment ponds. The treated water is nutrient rich and is sold for irrigation and fertilization.

A categorization of the potential source materials handled at the Simplot plant is indicated below:

SIMPLOT POTENTIAL SOURCE MATERIALS	CLASSIFICATION
• phosphate ore	• feedstock
• gypsum solids and liquids	• waste
• fertilizer formulations	• products
• waste oils and solvents	• recycled
• sulfur	• feedstock
• irrigation water	• recycled by land application
• UAN-32	• product
• treatment pond sediment	• waste
• office trash	• waste
• former east overflow pond sediments	• waste

1.2.2.1 Gypsum Solids and Liquids

The gypsum produced from the phosphoric acid process is slurried (25- to 40-percent solids) and pumped to the top of the gypsum stack. A series of perforated high-density polyethylene (HDPE) pipes located beneath the gypsum stacks collects some of the water used to slurry the gypsum, and this recovered water is recycled for further use in plant processes.

1.2.2.2 Waste Oils and Solvents

Waste oils are separated from water in a waste oil separator prior to collection in a waste oil storage tank. These waste oils are collected weekly for recycling by Cowboy Oil. Spent solvents are collected by Safety Kleen for recycling.

1.2.2.3 Noncontact Water and Laboratory Wastes

Boiler and cooling tower blowdown, compressor coolant water, demineralizer regeneration water, storm water, and laboratory wastes (i.e., acids, ammonia, and sodium hydroxide) are collected and treated in a series of lined ponds described in Section 1.2.3.3.

1.2.2.4 Irrigation Water

Nutrient-rich noncontact water and stormwater treated in the series of three lined ponds, north of the plant between Highway 30 and the Portneuf River, have been sold for irrigation/fertilization since July 1980 under a joint land-application permit with the City of Pocatello. Prior to July 1980, the treated water was discharged to the Portneuf River (NPDES Permit ID000067).

The EPA funded the Joint Waste Treatment Feasibility Study, Project EPA P0000080-03, which evaluated effluent handling alternatives available to the Pocatello STP and local industries. The study evaluated the suitability of wastewaters for irrigation, including characteristics of nutrient level, salinity, organic loading, sodium absorption ratio, and trace elements. The trace elements evaluated included aluminum, arsenic, boron, cadmium, chromium, cobalt, copper, fluoride, iron, lead, manganese, nickel, selenium, and zinc. The recommendations from the study in Report No.

219 concluded that "the EPA and the State Division of Environment should, where possible, assist and encourage the City of Pocatello and J.R. Simplot Company toward the completion of the land application project. Implemented by: Idaho Department of Health and Welfare and EPA." The recommendation was given force by an EPA AOC in 1978.

Under the AOC, Simplot chose to eliminate discharges to the Portneuf River by land application of the nutrient-rich water under the State of Idaho Land Application permit system. In 1992, a permit was issued to Simplot and the City of Pocatello for operation of part of the system (Land Application No. LA-000104, 8/17/92).

A comparison of analytical data for Simplot's irrigation water with the EPA's land-application limits for wastewater shows that the concentrations of the various inorganic compounds are considerably below the EPA-recommended concentration limits.

1.2.2.5 Air Emissions

Air emissions from the Simplot facility are regulated by the state of Idaho (Air Permit 1260-0060). The permit covers gaseous and/or particulate emissions from ore handling activities, individual process plants, and the reclaim cooling towers. Simplot has made a number of plant modifications to substantially reduce particulate matter emissions. Included in the plant modifications was the elimination of calciner units in 1990 and unenclosed raw ore handling facilities in 1991. Elimination of calciner units reduced total plant carbon monoxide and oxides of nitrogen emissions. Elimination of the unenclosed raw ore handling facilities through the use of a slurry pipeline greatly reduced not only the total particulate matter emissions but fluoride and radionuclide emissions as well.

1.2.3 WASTE OR BY-PRODUCT MANAGEMENT FACILITIES

There are currently two gypsum stacks and several ponds at the Simplot facility. In addition, a solid waste landfill and a trash landfill are also used at the facility. A brief summary of each of these waste management facilities, including the types of wastes contained, is presented below.

1.2.3.1 Gypsum Stacks

There are two gypsum stacks on the facility grounds south of the plant operating areas. The original gypsum stack is the northernmost of the two stacks. The southernmost stack has been in use since 1966. Together, the two gypsum stacks occupy an area of approximately 340 acres. Simplot is in the process of raising the level of the lower, northernmost stack and merging the two stacks into one.

1.2.3.2 Former East Overflow Pond

The former east overflow pond was an unlined surface impoundment approximately 0.8 acres in size. It is located east of the plant operational areas. When operational, this pond received surface water runoff as well as excess process water from the plant water reclaim system in the event of a power failure or other process upset. Reclaimed system water included gypsum filter wash water, scrubber water, and cooling tower water. Water collected in this pond was pumped back to the reclaim water system. The pond also had an emergency discharge system that enabled discharge of water to the water treatment ponds via gravity flow through an underground pipeline. Use of the former east overflow pond was discontinued in August 1993 when a lined replacement pond (Reclaim Water Pond No. 1), adjacent to the original pond, was put into service.

1.2.3.3 Water Treatment Ponds

A series of lined ponds, north of the plant between Highway 30 and the Portneuf River, is used to treat the noncontact water, laboratory wastes, and storm water referenced in Section 1.2.2.3. The noncontact water is collected by a facility drainage system and flows through a pipe under Highway 30 into a plastic-lined holding pond for pH adjustment or into a lined equalization pond.

Water in the holding pond is pH-adjusted with soda ash before it flows to a concrete-lined settling pond for clarification. After the suspended solids have settled out of the water, the treated water flows to the equalization pond where it is combined with the water that did not require pH adjustment. The equalization pond liner is constructed of clay, bentonite, and compacted soil to which a chemical sealant has been added. Equalization pond water is pumped to a large lined surge pond located north of Interstate 86 for storage prior to being used for irrigation and fertilization. The surge pond liner construction is the same as that of the equalization pond. The treated water is nutrient-rich and has been sold for irrigation/fertilization since July 1980 under a joint land application permit with the City of Pocatello as described in Section 1.2.2.4. From time to time, sediments have been dredged from the ponds and transferred to an unlined dewatering pit adjacent to the ponds. Sediments were dredged from the equalization pond on only one occasion in late 1991 or early 1992. Prior to that time, sporadic unsuccessful attempts were made to remove sludge/sediments from the solids settling pond. Sediments have not been removed from the unlined dewatering pit.

1.2.3.4 Landfills

A solid waste landfill is located between the gypsum stacks. It lies partly on native soil and partly on the northernmost gypsum stack. The initial date of operation of this landfill is unknown. Construction wastes, demolition rubbish, and neutralized solid wastes from spills were disposed of in the solid waste landfill.

Simplot previously disposed of general office waste and garbage from the lunchroom in two trash landfills. The more recently used landfill is located above the southernmost gypsum stack; the older landfill is northwest of the more recently used landfill. Simplot now sends trash offsite.

1.3 SUMMARY OF PREVIOUS INVESTIGATIONS

The EMF study area has been the subject of a number of historical investigations, conducted to address a variety of resource and ecological issues. It should be noted that the findings of the previous investigations are presented in this section as reported by the study authors, and do not necessarily reflect the findings of the RI. The scope of these studies ranged from peer reviewed papers to unpublished undergraduate studies. The investigations focused on specific media, as follows:

- Regional studies of the EMF study area – media investigated include springs, groundwater, surface water, river sediments, aquatic ecology, terrestrial wildlife and habitats, vegetation, and air quality.
- Studies on the FMC facility property – media investigated include soils and groundwater.
- Studies on the Simplot plant property – media investigated include groundwater.

This section summarizes the previous investigations performed in the EMF study area, and at the FMC and Simplot facilities. Only brief overviews of the area-wide investigations are provided in this section. These investigations are discussed in more detail in Appendix A.

This section focuses first on regional investigations conducted in the EMF study area (Sections 1.3.1 through 1.3.6), and then on investigations of the EMF facilities (Sections 1.3.7 and 1.3.8). Of the area-wide studies, those addressing the general water chemistry of springs and groundwater are presented initially, as they provide an overview of the sources and movement of unimpacted surface water and groundwater. They are followed by characterizations of the sources of water and the relationship of spring and groundwater chemistry, which provide preliminary insight into the source and distribution of chemical constituents.

Accordingly, Section 1.3 is organized as follows:

- Section 1.3.1 discusses the general water chemistry of both springs and groundwater in what is now referred to as the EMF study area.

- Sections 1.3.2 through 1.3.4 identify the constituents present in specific media in the EMF study area.
- Section 1.3.5 discusses previous investigations of the aquatic ecology of the Portneuf River and of terrestrial wildlife and habitats within the EMF study area.
- Section 1.3.6 summarizes previous investigations of air quality in the EMF study area.
- Sections 1.3.7 and 1.3.8 summarize past investigations conducted at the FMC and Simplot facilities, respectively.

The regional setting of the EMF study area is shown in Figure 1.3-1.

1.3.1 CHARACTERIZATION OF GENERAL WATER CHEMISTRY

Previous investigations conducted in the EMF study area involved the characterization of the general water chemistry of springs (downgradient of the EMF facilities) and groundwater. Towards this end, basic water chemistry data on the naturally occurring constituents in springs and groundwater were collected and analyzed. This section presents the results of and conclusions drawn by the previous investigations for the springs studied, followed by the same for groundwater. Additional details on each investigation are presented in Appendix A.

1.3.1.1 Springs

Previous investigations conducted at springs along the Portneuf River within the EMF study area are as follows:

- Perry et al. (1990) and Goldstein (1981) attempted to characterize the source(s) of springs studied.
- Jacobson (1982, 1984, and 1989) monitored the water quality of Batiste Springs as part of hydrogeologic investigations conducted over a period of 7 years.

In general, data collected during each investigation showed that most of the spring waters along the Portneuf River belong to a calcium bicarbonate system. Perry et al. (1990) went on to classify 27 of the 28 springs studied into four groupings of springs within the overall calcium bicarbonate system, based on additional characteristic parameters such as conductivity, selected nutrients, and fluoride. These four groups, indicated in Figure 1.3-2, were identified as follows:

- Batiste System (Group I)
- Swanson Road System (Group II)
- East Side System (Group III)
- Papoose System (Group IV)

The Perry study did not include Willow Spring (Figure 1.3-1) in the four groupings because it was markedly different, having a sodium/potassium chloride water chemistry and overall higher ionic concentrations than any other spring studied.

Both Perry et al. (1990) and Goldstein (1981) attempted to characterize the source of water for the springs sampled in each respective study. However, conclusions drawn by both studies could only be tentative, as each study examined only limited data. The Perry study examined a narrow geographical area (less than 2 square miles), and the Goldstein study examined a restricted number of springs (seven).

Both Perry and Goldstein suggested that the springs in the Portneuf River basin issue from the Michaud Gravel and the American Falls Lake Bed Formation, which also underlie the EMF study area. Additionally, Perry noted that, based on water chemistry, Groups II, III, and IV each included springs from both the east and west side of the Portneuf River, suggesting that the river is not a hydraulic barrier to subsurface flow in the area north of I-86. Additional data collected during the RI indicate that the river is, in fact, a hydraulic barrier north of I-86 (Section 3.3).

Perry described the water chemistry of these three groups as representing downgradient (downstream) gradation (i.e., paralleling the discharge of the Portneuf River), suggesting that these springs may represent underflow from the river. Both authors suggested that springs in the Batiste System represent a source of water other than that of the rest of the springs studied.

As part of the USGS hydrogeologic investigations, Jacobson collected water chemistry data for five springs in 1980 (Jacobson, 1982). Additional water chemistry data were collected for two of these springs [Batiste and Twenty-West in 1981 and 1982 (Jacobson, 1984), and Batiste Spring from 1982 through 1987 (Jacobson, 1989)]. The investigations were initiated as a result of degraded water quality found in the Pilot House Well in 1972. The data were collected to monitor changes in groundwater and spring quality in the Michaud Flats area. Incidental to the main focus of the investigation, the study concluded that Batiste Spring had been impacted, and noted the proximity of the spring to the industrial ponds at the EMF facilities. No attempt was made by Jacobson to characterize the nature of the impact.

1.3.1.2 Groundwater

This section briefly discusses previous investigations of groundwater chemistry, based on data collected during the following studies:

- Perry et al., 1990
- Jacobson, 1982, 1984, and 1989
- Goldstein, 1981

Water chemistry data were collected from various springs along the Portneuf River and from 16 wells in the EMF study area. These wells are identified in Figure 1.3-3.

The studies concluded that most of the wells belong to a calcium-bicarbonate system. Furthermore, most of these wells were found to be comparable to one or more of the four spring groups identified by Perry et al. (1990) (Section 1.3.1.1). Eight wells were found to have water chemistry comparable to the Papoose System: Papoose Springs Fish Farm, Pumping Station, New Pilot House, Idaho Power, Michaud/USGS-1, FMC-3, Williamsen, and Tank Farm wells. Two wells were comparable to the Swanson Road System: Rowland and Carlson wells. One well was comparable to the Batiste System: SWP-4. One well was intermediate between the Batiste and Papoose systems: SWP-5. The Perry study likened two wells, Lindley and FMC-1, to a Batiste/Papoose System, with increased levels of chloride. One well, Crockett, was not comparable to any of the four spring groups, but was comparable to the sodium chloride water chemistry of Willow Spring. One well, Old Pilot House, was not comparable to any spring and had a sodium/potassium carbonate water chemistry.

1.3.2 IDENTIFICATION OF CONSTITUENTS IN BATISTE SPRING

This section addresses Batiste Spring (Figure 1.3-1) since it is the only spring identified by previous investigations (e.g., Perry et al., 1990, and Goldstein, 1981) as being impacted by anthropogenic activities at the EMF facilities. Previous investigations conducted at Batiste Spring are as follows:

- Perry et al., 1990.
- Goldstein, 1981 — The final report also referenced a 1979 report on a previous study conducted by Balmer and Noble of water resources for the Fort Hall Indian Reservation, including Batiste Spring.
- U.S. Geological Survey (USGS), 1977 — Batiste Spring was addressed in an environmental impact statement (EIS) prepared by the USGS.
- E&E, 1988.

Both the Perry and Goldstein studies showed increased sulfate, calcium, and nutrient concentrations at Batiste Spring relative to the other springs studied. Water quality of Batiste Spring was described by Balmer and Noble (Goldstein, 1981) as showing an increase in levels of hardness, chloride, sulfate, phosphate, nitrate, and ammonia from 1930 through the 1970s. The report also found fluctuating concentrations of mercury, arsenic, and cadmium in Batiste Spring in the 1970s.

Additional investigations identified elevated levels of phosphate in Batiste Spring (USGS, 1977; E&E, 1988). The phosphate levels were attributed to discharges to the Portneuf River from the EMF facilities.

A more comprehensive discussion of these previous investigations is provided in Appendix A of this report.

1.3.3 Identification of Constituents in Groundwater

Previous investigations that examined constituents in groundwater are as follows:

- Goldstein, 1981 — The final report also referenced a 1979 report on a previous study conducted by Balmer and Noble of water resources for the Fort Hall Indian Reservation, which included groundwater.
- Jacobson, 1982, 1984, and 1989.
- E&E, 1988.

These previous investigations reported the presence of elevated levels of metals and some general water quality parameters in groundwater.

The Goldstein and Jacobson studies attributed the elevated parameters in the Crockett well to the EMF facilities. The E&E investigation also found elevated concentrations of metals in the wells examined; furthermore, the study correlated the findings with some potential sources at the EMF facilities.

The EMF site was placed on the National Priorities List (NPL) on the basis of E&E's findings.

Further details on these investigations are presented in Appendix A.

1.3.4 Identification of Constituents in Surface Water and Sediments

This section summarizes the results of previous investigations of constituents in surface water and sediments of the Portneuf River. This discussion is based on the following previous investigations:

- Surface water quality was examined by Ecology Consultants (1977) and Campbell et al. (1992).

- Perry (1977) studied the impacts of effluent discharges from various sources on the Portneuf River.
- Mazanowski (1992) attempted to characterize sediment quality with respect to heavy metal concentrations for the Portneuf River sediments.

The locations of surface water and sediment sampling points included in these studies and, for reference purposes, RI surface water and sediment sampling points are shown on Figure 1.3-4.

The presence of elevated nutrients in surface water was investigated by Ecology Consultants and Campbell et al. The Ecology Consultants study found an increase in nutrient concentrations at stations 4 and 7 (Figure 1.3-4), based on samples collected in August 1977.

The Campbell investigation included a comparison of data collected in 1972 and 1991-1992, from locations indicated in Figure 1.3-4. The study concluded that while some stations showed decreased phosphate levels, overall phosphate levels in the river had not changed over the 20-year period. Campbell reported that increased phosphate levels found at one station were possibly attributable to the Pocatello Sewage Treatment Plant (STP) (Figure 1.3-1), Batiste Spring, or "gradual saturation of the river bottom sediments with phosphates as a result of eutrophication".

The 1977 Perry study presented the results of a water quality sampling program to characterize effluent impact on the Portneuf River. (See Figure 1.3-4 for sampling locations.) The sampling program concluded that the surface water quality was impacted during the period of the study as a result of operations at the EMF facilities, as well as the STP, Batiste Springs Fish Farm, and Papoose Springs Fish Farm.

The 1992 Mazanowski study attempted to quantify four heavy metals (cadmium, copper, lead, and zinc) associated with the clay-silt fraction of sediment from the Portneuf River. The locations of samples collected for this effort are shown on Figure 1.3-4. The investigation found metal concentrations above mean concentrations within the study area.

1.3.5 ECOLOGICAL INVESTIGATIONS

This section summarizes the results of previous investigations of the EMF study area ecology. These investigations included aquatic surveys of the Portneuf River and studies of terrestrial wildlife and habitats. Additional information on investigations addressed in this section is provided in Appendix A.

1.3.5.1 Aquatic Surveys

Aquatic surveys of Portneuf River that were conducted in the past are as follows:

- Minshall and Andrews, 1973
- Buikema, 1975
- Ecology Consultants, 1977
- City of Pocatello, 1989

Surveys of aquatic ecology were conducted from the late 1960s to the mid-1970s. Because of the changes in discharge practices at the EMF facilities and other conditions in the river since that time, the data provided by the surveys may have limited relevance to the EMF site characterization study. The most recent aquatic ecology investigations of the Portneuf River are summarized in Section 3.7.

Aquatic surveys were conducted by Minshall and Andrews (1973) over the approximately 98-mile (157-km) long course of the Portneuf River. The study examined the distribution of benthic invertebrates along the stream course. The investigation indicated the possibility of toxic conditions below the EMF facility discharges. The 1975 Buikema survey examined the macrobenthos in the Portneuf River, along an approximate 655-foot (200-m) stretch of the river above and below the FMC and Simplot facility outfalls. Generally, the Buikema data obtained downstream from the effluents showed no major impact of these outfalls on the benthos. Another aquatic survey, prepared by Ecology Consultants (1977), addressed benthic fauna as well as attached algae (periphyton). The study concluded that the discharges had an effect upon most of the aquatic parameters studied.

Aquatic habitat between I-86 and Siphon Road was investigated by the City of Pocatello (1989) to evaluate possible effects of treated wastewater on the biology and chemistry of the Portneuf River. The area of focus for the bioassessment was the Portneuf River in the immediate vicinity of the STP's outfall. Sampling sites were selected above the outfall, within the mixing zone, and downstream from the mixing zone. Two seasonal sampling periods (autumn 1988 and summer 1989) were specified for the bioassessment. The study concluded that the ammonia-nitrogen load contained in the STP's effluent increased the ammonia content of the Portneuf River below the Roland creamery, and that a zone along the west bank of the river appeared to have been impacted minimally by the STP's effluent. The report further concluded that results of taxanomic analysis of benthic samples suggest that there is environmental stress associated with the effluent discharged from the STP.

1.3.5.2 Terrestrial Investigations

Previous investigations regarding terrestrial wildlife and habitats are as follows:

- State of Idaho and Others, 1965 - 1992
- Henny and Burke, 1990
- Low and Mullins, 1990
- Severson and Gough, 1979

The Department of Health and Welfare, Division of Environment Quality, State of Idaho directed studies of fluoride levels in vegetation to be conducted in the area surrounding the EMF facilities from the late 1960s to 1992. These investigations were conducted by the University of Idaho, Department of Agricultural Biochemistry and Soils (1965-1971), Department of Bacteriology and Biochemistry (1972-1980), and by Miller (1986-1987, 1990-1992). One shortcoming of these investigations is that the species collected for the study were not identified. Specifically, in many cases it could not be clearly determined from the data presented whether the plants sampled were annuals or perennials. Therefore, conclusions could not be made regarding the relationship of fluoride deposition and uptake by wildlife feeding on the vegetation and, hence, none are presented here.

Similarly, the results of the Henny and Burke (1990) study, which documented fluoride concentrations in black-crowned night herons, are not discussed in this section. The herons evaluated were not year-round residents and migrated to Mexico, where they were potentially exposed to other chemical constituents, such as the pesticide DDT. In addition, the study itself concluded that further research was needed to distinguish age effects from fluoride effects in wild avian populations.

Low and Mullins (1990) conducted a reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the American Falls Reservoir area from 1988-1989. The purpose of the study was to determine whether potentially toxic compounds associated with irrigated drainage existed in surface, groundwater, bottom sediment, aquatic plants, benthic invertebrates, fish, and waterbirds in the American Falls Reservoir area. The authors concluded that, based upon general observations on health and diversity of biota during the field season, the study area did not appear to have a serious avian reproductive, habitat destruction, or food-chain biomagnification problem that could be associated with irrigation drainage.

Severson and Gough (1979) conducted a study in May 1975 to assess potential impacts of emissions from the EMF facilities on sagebrush and grasses. Vegetation samples were collected from distances of up to 40 miles (64 km) upwind (to the south) and downwind (to the north) of the facilities, and analyzed for 70 elements. The authors concluded that seven elements (cadmium, chromium, fluorine, selenium, uranium, vanadium, and zinc) were related to emissions from the EMF facilities. The study also found a correlation between constituent concentrations in the plants and distance from the facilities. The study relied on linear regression analysis of element concentrations measured along transects emanating from the facilities to assess whether individual element concentrations were associated with the facilities. The paper did not attempt to assess the spatial extent of impact.

1.3.6 AIR QUALITY

This section discusses previous air quality investigations conducted at the EMF study area. Over the past 20 years, ambient air quality monitoring has been performed by the State of Idaho and the FMC and Simplot facilities. The monitoring was performed to ascertain and monitor regional and local trends in ambient air quality, and focused on state and federal ambient air quality standards.

Historically, monitoring has been conducted for total suspended particulate (TSP) matter, particulate matter whose size is less than 10 microns (PM_{10}), sulfur dioxide (SO_2), and fluorides. The following are brief descriptions of the monitoring programs corresponding to each parameter.

1.3.6.1 *Particulate* (TSP and PM_{10}) *Monitoring*

Particulate monitoring for TSP at the EMF facilities began in 1971-1972, when the State of Idaho installed TSP monitors at the Pocatello STP. This equipment was later augmented by PM_{10} monitors in 1986. In 1988, PM_{10} monitors were also installed at locations 3 to 4 miles from the Simplot facility. In addition, FMC has conducted a program of particulate (TSP) monitoring since 1975 (enhanced with PM_{10} monitors in 1984), with the installation of two monitors within the facility boundaries, and a third about 50 feet away from the monitor at the Pocatello STP.

As a result of these monitoring programs, the EMF study area was identified as part of a TSP nonattainment area, and later, part of the PM_{10} nonattainment area.

1.3.6.2 Sulfur Dioxide (SO_2) Monitoring

Ambient SO_2 monitoring has been conducted by Simplot since 1978. Simplot has operated SO_2 monitors at the following locations: the Pocatello STP; north of the Rowland creamery; the vicinity of the Simplot water treatment ponds; in Chubbuck, approximately a quarter mile (0.4 km) from Rio Vista; approximately 1 mile (1.6 km) south-southeast of the Pocatello STP SO_2 monitor, coincident with the site 1 meteorological station at Simplot's surge pond; and a quarter mile (0.4 km) east of the Pocatello STP on Batiste Road. This last location was added in 1986 because the area was identified by atmospheric dispersion modeling as the calculated point of maximum SO_2 concentrations impacting on local elevated terrain.

Data from these monitoring stations indicated that SO_2 emissions from all sources are well under the threshold concentrations specified by state and federal ambient air quality standards.

1.3.6.3 Fluoride Monitoring

Under state of Idaho air quality rules, fluoride levels in forage material are required to be monitored. Forage fluoride sampling has been conducted in the area since the 1950s.

Historically, elevated levels of forage fluoride have been observed in the immediate vicinity of the FMC and Simplot facilities. Plants from areas having the highest fluoride readings typically are east and southeast of the facilities. Vegetation in these areas is sparse, consisting primarily of sagebrush and scrubgrass.

1.3.6.4 Airborne Deposition and Soils Impacts

In May 1975, Severson and Gough (1979) conducted a survey for the USGS to assess potential impacts of emissions from phosphate-processing facilities to offsite soils. Samples were collected from distances up to 40 miles (64 km) upwind (to the south) and downwind (to the north) of the facilities. Surficial soil samples were collected at a depth of about 5 cm.

Subsurface samples were generally collected at a depth of 80 to 100 cm, though at places where the underlying rock was near the surface, samples were as shallow as 50 cm.

The study reported that 9 of 58 elements measured in surficial soils were related to EMF facility operations. The nine constituents were beryllium, fluorine, iron, lead, lithium, potassium, rubidium, thorium, and zinc. However, the study did not find a correlation between element concentrations in subsurface soils and the EMF facilities. The general observation that some elements in the surficial soils appeared to be related to the facilities whereas elements in the subsurface soils did not is consistent with findings of the RI (Section 4.3).

1.3.7 FMC Facility Investigations

Previous investigations conducted at the FMC facility are as follows:

- Geraghty and Miller, Inc., 1982a and 1982b
- FMC, 1991b

G&M reviewed groundwater analytical data from the FMC onsite wells, offsite wells, and nearby springs to determine the effect of FMC's operations on groundwater quality. Nineteen monitoring wells were installed, and groundwater samples were collected at quarterly intervals from August 1980 through November 1981. G&M reported elevated total dissolved solids concentrations extending from Pond 7E (Figure 1.1-1) to the Portneuf River, as well as a smaller warm water plume suspected of being caused by the slag operation. The total dissolved solids plume followed the groundwater flow and discharged into the Portneuf River through a series of small springs on the west bank of the Portneuf River, two of which are Swanson Road Spring and Batiste Spring (Geraghty and Miller, Inc., 1982a and 1982b).

An FMC Facility Assessment (FFA) was also conducted from September to December 1990 (FMC, 1991b). The FFA further characterized the hydrogeologic conditions and established a groundwater monitoring program to comply with applicable RCRA requirements. The field investigation conducted in 1990 included collection of one round of groundwater samples, surface soil samples, and subsurface soil samples.

The hydrogeologic investigation consisted of the following:

- Installation of 36 onsite wells
- Collection and analysis of groundwater samples
- Aquifer testing
- Measurement of groundwater levels

Groundwater samples were collected from each of the newly installed wells immediately after development, and from 28 onsite and offsite existing wells. The locations of wells sampled during the FFA are shown in Figure 1.3-5. Wells installed by Geraghty and Miller, Inc., (G&M) are identified with a "TW" prefix; wells installed in 1990 are numbered 101 to 137; and wells currently or previously used as facility production wells are identified with the prefix "FMC." Named wells are private water supply wells.

The FFA identified three areas where the distribution of constituents in groundwater were elevated within the FMC facility boundary. Three dissolved constituents (arsenic, nitrate, and selenium) were found to be at elevated levels. In addition, dissolved constituents (iron, lead, manganese, potassium, sodium, alkalinity, chloride, fluoride, sulfate, total dissolved solids, total phosphorus, and orthophosphate) were detected in underlying shallow groundwater at levels higher than the background levels identified by G&M as characteristic of the area. Elevated levels were restricted to the uppermost (shallow) interval.

During the FFA, 12 surface soil samples and 105 subsurface soil samples were also collected. In the surface soils samples, nine parameters (cadmium, chromium, lead, silver, vanadium, zinc, fluoride, total phosphorus, and orthophosphate) were detected at concentrations above background. In the subsurface soils samples, arsenic, cadmium, zinc, fluoride, orthophosphate, and total phosphorus were detected at elevated concentrations.

1.3.8 SIMPLOT FACILITY INVESTIGATIONS

In 1984, PEDCo Environmental, Inc. (PEI), under contract to the EPA, installed six monitoring wells at the Simplot facility. The PEI (1985) investigation detected low levels of arsenic and cadmium concentrations in groundwater. Low concentrations of barium, chromium, lead, vanadium, and zinc were also detected in the groundwater samples. Wells with the prefix "PEI" were installed during these investigations. Wells with the prefix "SWP" are Simplot facility production wells.

1.4 REFERENCES

Bechtel, 1993. Phase II Work Plan. **INCOMPLETE.**

Bechtel, 1992. Remedial Investigation/Feasibility Study Work Plan. **INCOMPLETE**

Buikema, Arthur L. Jr., 1975. "Final Report for Macrobenthos Study of the Portneuf River," prepared for FMC Corporation, Industrial Chemical Division, Pocatello, Idaho, August 22.

Campbell, T., S. Wood, R. James, R. Rodriquez, and G. Arcand, 1992. "An Evaluation of the Concentration of Orthophosphate in the Portneuf River, Idaho," Journal of the Idaho Academy of Science, Vol. 28, No. 1, June 1992.

City of Pocatello, 1989. "Assessment of Possible Effects on Pocatello's Treated Wastewater on the Biology and Chemistry of the Portneuf River," Final Report, November.

Code of Federal Regulations, 40 CFR Part 261.

CRC, 1980. "CRC Handbook of Chemistry and Physics," 61st edition, CRC Press Inc., 1980.

Ecology & Environment, Inc., 1988. "Site Inspection Report for FMC/Simplot Sites, Pocatello, Idaho," April.

Ecology Consultants, Inc., 1977. "Aquatic Survey of the Portneuf River near Pocatello, Idaho," Submitted to J.R. Simplot Company, Minerals and Chemical Division, September.

EPA, 1988. "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA."

EPA, 1991. "Administrative Order on Consent for Remedial Investigation/Feasibility Study for Eastern Michaud Flat Site," U.S. EPA Docket No. 1090-01-06-104, signed May 30, 1991.

Federal Register, Volume 55, No. 169, August 30, 1990, pp. 35502-35525.

FMC Corporation, 1991a. "RCRA Part B Permit Application, FMC Corporation Elemental Phosphorus Manufacturing Plant, Pocatello, ID," March.

FMC Corporation, 1991b. "FMC Facility Assessment," Pocatello, Idaho, June.

FMC and Simplot, 1993. "Response to EPA Comments on Phase II Site Investigation Plan," by FMC and Simplot, August 9, 1993. **INCOMPLETE**

Geraghty and Miller, Inc., 1982a. "Ground-Water Data from the FMC Plant Vicinity, Pocatello, Idaho," July.

Geraghty and Miller, Inc., 1982b. "Hydrogeologic Conditions in the Vicinity of the FMC Plant, Pocatello, Idaho," November.

Goldstein, F.J., 1981. "Hydrogeology and Water Quality of Michaud Flats, Southeastern Idaho," Idaho State University thesis.

Henny, C.J., and P.M. Burke, 1990. "Fluoride Accumulation and Bone Strength in Wild Black-crowned Night-Herons," Arch. Environ. Contam. Toxicol. 19:132-137.

Jacobson, N.D., 1982. "Ground-Water Conditions in the Eastern Part of Michaud Flats, Fort Hall Indian Reservation, Idaho," U.S. Geological Survey Open-File Report 82-570, Boise, Idaho, June.

Jacobson, N.D., 1984. "Hydrogeology of Eastern Michaud Flats, Fort Hall Indian Reservation, Idaho," U.S. Geological Survey Open-File Report 841-4201, Boise, Idaho.

Jacobson, N.D., 1989. "Water-Quality Data for Selected Sites on Michaud Flats, Fort Hall Indian Reservation, Idaho, December 1982 to July 1987," U.S. Geological Survey Open-File Report 89-71, Boise, Idaho.

Low, Walton H. and William H. Mullins, 1990. "Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated With Irrigation Drainage In The American Falls Reservoir Area, Idaho, 1988-89," U.S. Geological Survey Water Resources Investigations Report 90-4120. Boise, Idaho.

Mazanowski, William, 1992. "Quantitation of Heavy Metals Associated with the Clay-silt Fraction of Sediment from the Portneuf and Blackfoot Rivers in Southeast Idaho," Idaho State University, Chemistry Department, Independent Research.

Miller, G.W., 1986. "Levels of Fluoride in Vegetation Samples Collected from the Soda Springs and Pocatello Areas During the 1986 Growing Season," Utah State University Foundation, December 1986. Idaho Air Quality Bureau, 450 West State Street, Boise, Idaho.

Miller, G.W., 1987. "Levels of Fluoride in Vegetation Samples Collected from the Soda Springs and Pocatello Areas During the 1987 Growing Season," Utah State University Foundation, December 1987. Report for the Idaho Department of Health and Welfare - Division of the Environment Air Quality Bureau, 450 West State Street, Boise, Idaho.

Miller, G.W., 1990. "Levels of Fluoride in Vegetation Samples Collected from Pocatello Areas During the 1990 Growing Season," prepared for the Simplot Corporation, December.

Minshall, G. Wayne and Douglas A. Andrews, 1973. An ecological investigation of the Portneuf River, Idaho; a semiarid-land stream subjected to pollution. Freshwater Biology 1973 Vol. 3, p-1-30. (Idaho State Univ. Pocatello, Idaho).

PEI, 1985. "Evaluation of Waste Management for Phosphate Processing," consulting report prepared for U.S. EPA by PEI Associates, Inc., Cincinnati, Ohio, April.

Perry, James A., W.H. Clark, and O.J. Smith, 1990. "Groundwater Classification through Spring Chemistry: The Lower Portneuf River, Southeastern Idaho," Journal of the Idaho Academy of Science, Vol. 26, No. 1/2, June/December.

Perry, James A., 1977. "Water Quality Status Report, Lower Portneuf River," Idaho Department of Health and Welfare, Report No. WQ-22, Final Report.

Piper, A.M., 1944. "A Graphic Procedure in the Geochemical Interpretation of Water Analysis," Transactions, American Geophysical Union, Vol. 25, p. 914-923.

Severson, R.C., and L.P. Gough, 1979. Environmental Implications of Element Emissions from Phosphate-Processing Operations in Southeastern Idaho, Geological Survey Professional Paper 1083.

State of Idaho and Others, 1965 - 1992. **INCOMPLETE**

Stiff, H.A., 1951. "The Interpretation of Chemical Water Analyses by Means of Patterns," Journal of Petroleum Technology, Vol. 3, No. 10, Section 1,2,3.

USGS, 1971a. Topographic Map, Michaud, Idaho.

USGS, 1971b. Topographic Map, Pocatello, Idaho.

USGS, 1977. "Development of Phosphate Resources in Southeastern Idaho: Final Environmental Impact Statement."

2.4 SURFACE WATER AND SEDIMENT INVESTIGATION

A surface water and sediment investigation was conducted to identify the potential effects of EMF activities on the Portneuf River. Segments of the Portneuf River and associated springs and ponds were sampled to identify differences in water quality along the river. Section 2.4.1 discusses data collection activities related to surface water investigation, while the sediment investigation is addressed in Section 2.4.2.

The surface water and sediment sample locations are listed in Table 2.4-1. Locations where samples were collected during July 1992 are shown in Figure 2.4-1. Subsequent surface water samples were collected at 24 locations when weather and river conditions permitted. The samples were collected quarterly from July 1992 through April 1993. Supplementary sediment samples were collected during December 1992. In addition, surface water and sediment samples were collected during the Phase II field activities in July 1993 and the Phase III activities in June 1994. Phase III samples were analyzed for mercury only. Collection of additional sediment samples from the area of the IWW ditch outfall and the Portneuf River delta is described in Section 2.7.

Concurrent with the sampling of surface water, Portneuf River flow rates were measured at five of the sampling locations when weather and river conditions permitted. These locations are identified in Table 2.4-1. Flow rates were measured during each of the four rounds of surface water sampling. Flow rates were measured to develop a waterflow budget for the river so that flow contributions from springs and streams along the river could be estimated.

2.4.1 SURFACE WATER INVESTIGATION

The surface water sampling investigation was designed to provide information to evaluate the potential impacts of chemical loading to the water quality of the Portneuf River as a result of anthropogenic activities.

2.4.1.1 Sampling Locations Selection Process

The specific surface water sample locations were selected to provide:

- Samples upstream and downstream of the EMF facilities
- Samples at seeps and springs that discharge to the Portneuf River
- Samples below outfalls or other anthropogenic discharges to the Portneuf River watershed

Two sets of sample locations specified in the RI/FS Work Plan (Bechtel, 1992b) were eliminated. The first, consisting of springs believed to be in the proximity of the Rowland creamery, was eliminated because the springs could not be located. The second set, consisting of the "old Simplot discharge" and the "old FMC discharge" points, was eliminated because they were determined to be the same as sediment sampling location 18 (Figure 2.4-1).

Surface water samples were taken in areas representative of the flowing river or springs. Samples were generally not taken in stagnant water unless the water was representative of overall stream conditions at that sampling location.

During Phase I, elevated levels of some constituents were observed in sediment samples in the vicinity of the IWW ditch outfall to the Portneuf River. The location of this outfall is location 17 in Figure 2.4-1. It appeared from the physical description of the sediment obtained from this location that slag from the FMC facility was present in the sample. To evaluate this possibility, additional surface water and sediment samples were collected during Phase II (July 1993) field activities in the vicinity of the outfall. Surface water samples were collected in a profile across the river at location 17. For this profile, samples were collected at seven locations across the channel, both at depth within the river channel and just below the water surface.

2.4.1.2 Sampling and Analysis Procedures

This section describes the documentation, sampling, and decontamination procedures followed during the surface water sampling investigation.

3.2 DRAINAGE AND SURFACE WATER HYDROLOGY

Section 3.2.1 presents the regional characteristics of surface waters in the EMF study area. This includes a description of river morphology and sediment deposition patterns. Section 3.2.2 discusses site-specific drainage patterns and potential runoff associated with storm events.

Due to the topography of the EMF facilities, surface water runoff does not leave the facilities during typical storm events. As discussed in Section 3.2.2, the runoff produced by the maximum observed storm would not exceed the holding capacity of local depressions within the facilities.

3.2.1 REGIONAL HYDROLOGY AND RIVER MORPHOLOGY

Major surface water features of the region include the Snake River, Portneuf River, and the American Falls Reservoir (Figure 3.2-1). The reservoir is an impoundment of the Snake and Portneuf rivers and Bannock Creek, among others; both rivers discharge into the reservoir at its east end. Figure 3.2-1 also summarizes data with respect to the drainage areas and the contribution of inflow of water and sediment from the rivers to the reservoir. The Snake River data are from the Snake River gauging station near Blackfoot (gauge 13069500); the Portneuf River is gauged at Pocatello (gauge 1307550), 17 miles upstream of the reservoir and at Tyhee Station, near Tyhee Road.

A more detailed discussion of the data on water flow and sediment transport of the Snake River, Portneuf River, and American Falls Reservoir is presented in Section 3.2.1.1. Also included is a discussion of river morphology and associated sediment deposition patterns.

Snake River

The Snake River has a moderately straight river channel, downcut into the basalts of the Snake River Plain. In places, the river is significantly entrenched into the basalts.

Upstream of the American Falls Reservoir, the Snake River drainage is 11,310 square miles (2.9 million hectares), including watersheds of the Blackfoot River, Henry's Fork, Teton River, and portions of western Wyoming (Figure 3.2-2). Sediments deposited in the American Falls Reservoir may originate from a large number of watersheds and reflect anthropogenic activities throughout this area.

A fraction of the sediments transported by the Snake River and subsequently deposited in the American Falls Reservoir is derived from the Phosphoria Formation, which crops out extensively throughout the upper Snake River drainage basin in western Wyoming and eastern Idaho (Swanson et al., 1953). Phosphoria Formation sediments will likely be found in the fine-grained suspended sediment load because the Phosphoria Formation is a shale, which weathers rapidly to clay and silt. This shale is the feedstock for the EMF facilities, and past releases from the facilities may be difficult to resolve from naturally occurring phosphoric shale in the reservoir sediments.

Portneuf River

The Portneuf River drainage area is approximately 1,250 square miles. In geomorphologic terms, the Portneuf River displays two distinct channel types: one is a high sinuosity pattern associated with bars and a low width/depth ratio; the other is a moderately straight pattern (low sinuosity) with a high width/depth ratio (Figure 3.2-3). Channel characteristics are associated with flow rates and riverbed gradient. The types of deposits sampled during the RI field investigation were predominantly fine-grained deposits collected from point bars, chute bars, and the local floodplain of the river (Figure 3.2-4). Results of this sampling are discussed in Section 4.5.

Upstream of the EMF facilities, the river flows in a relatively steep valley between the Pocatello and Bannock ranges (Figure 1.3-1). Near the EMF facilities, the river emerges onto the Michaud Flats along the base of the Bannock Range. The river runs across the flats incised in a shallow, flat-bottomed valley that widens from about 0.5 mile (0.8 km) at the Bannock Range to over 1.5 miles (2.4 km) near the reservoir. At the reservoir, the broad flat-bottomed area is called the Fort Hall Bottoms (Figure 3.2-5).

The river course increases in sinuosity from the Bannock Range area to the Fort Hall Bottoms. Where there is a distinct increase in gradient (typically 0.19 percent), the river becomes moderately straight. Where the gradient decreases (typically 0.11 percent), the river follows a high sinuosity pattern (Figure 3.2-4).

American Falls Reservoir

The American Falls Reservoir covers 88 square miles (22,800 hectares), and has a capacity of 1.7 million acre-feet (2,097 million cubic meters). The reservoir level fluctuates seasonally, with high levels occurring during peak runoff in spring. The maximum potential elevation of 4,354.5 feet above mean sea level is controlled by the height of the dam at American Falls. During high water levels, the reservoir floods much of the Fort Hall Bottoms, as evidenced by stressed trees along the banks (Fenwick, 1993a).

3.2.1.1 Sediment Load Analysis

An analysis of the average annual sediment load from the Snake and Portneuf rivers was performed to provide a basis for comparing the relative contribution of sediment to the American Falls Reservoir. Sediment-discharge curves were developed for three gauges on the Snake and Portneuf rivers from suspended sediment data collected by the USGS. Daily sediment loads for each station were estimated by applying the sediment-discharge curves to daily flow data also collected by the USGS and retrieved from the National Water Data Storage and Retrieval System (WATSTORE).

Daily flow measurements are recorded by the USGS for the Snake River at Blackfoot, Idaho, station and for the Portneuf River at Pocatello and at Tyhee Road (Figure 3.2-1). The Pocatello and Snake River stations have continuous flow records from 1950 through 1989; however, the Tyhee Road station only has records from May 1985 to September 1989 and after October 1990. The drainage area tributary to the Snake River gauge is 11,310 square miles, and the Portneuf

River tributary at the Pocatello gauge is 1,250 square miles. The drainage area tributary to the Portneuf River at the Tyhee gauge is not listed by the USGS.

Sediment samples have been taken sporadically at all three gauging stations by the USGS; the sediment data are presented in Table 3.2-1. Data from the Snake River for June of 1976 were affected by the Teton Dam failure on June 6, 1976, and were not used for this analysis.

By correlating the sediment data versus flow data, a sediment-discharge rating curve was estimated by a Least-Squares Regression analysis to find the best fit of the data to an equation of the form:

$$Q_s = a\,Q^N$$

where

Q_S = The daily sediment load, in tons (T) per day,

Q = The flow rate, in cubic feet per second (cfs),

a and N = Constants that define the equation.

The constants a and N were derived for each station, as well as the correlation coefficient. These values are presented in the following table. Figure 3.2-1 presents the measured and predicted sediment load versus stream flow for each station.

Station	Constants		Correlation Coefficient (R)
	a	N	
Snake River at Blackfoot	0.0000335	1.8727	0.74
Portneuf at Pocatello	0.001290	1.9409	0.91
Portneuf at Tyhee	0.0000916	2.015	0.81

The derived equations were used to estimate the daily sediment load using the measured daily average flow. For the Tyhee station, flow data are only available from May 1985 to September 1989, and after October 1990. Therefore, for the Tyhee station, only the sediment load for 1985-1990 was calculated. The flow records for the Blackfoot and Pocatello stations permit calculation of sediment loads for the period from 1950 through 1989. The daily sediment loads were used to compute monthly totals, which are presented in Table 3.2-2. The calculated sediment loads only represent suspended sediment. An additional component of sediment load is the bed load, which was not measured by the USGS and was not included in this analysis.

The Portneuf River at Tyhee gauge, located downstream from the Pocatello gauge, was found to have a lower sediment load for the years that the gauge records overlap. The 1986-1988 average load for the Portneuf River at Pocatello was 67,300 tons per year (T/year). For the same period, the average load of the Portneuf River at Tyhee was only 16,200 T/year. This is despite the fact that the 1986-1989 average flow at Pocatello was 340 cfs while at Tyhee the average flow was 570 cfs. As discussed in more detail in Section 3.3, the increase in flow between the two stations is due to recharge from underflow and springs along the Portneuf River. The sediment loads calculated in this analysis are estimates based on very limited data and should not be considered "exact" numbers for comparison of sediment transport rates at the three different stations. The analysis indicates that less sediment is transported via suspended load at the Tyhee station than at the Carson Street gage in Pocatello. The deposition of suspended sediments occurring between the two gaging stations is also described in the City of Pocatello's STP assessment report of the Portneuf River, and in various other articles that describe the eutrophic, slow-moving, nature of the lower Portneuf River. The City of Pocatello's STP report describes a change in river character as "...the lower Portneuf exhibits changes in physical habitat as the gradient lessens and the river enters the area known as Michaud Flats. Between Highway I-15 downstream to Siphon Road, the Portneuf's channel changes from a substratum dominated by cobble and gravel to reaches with slower current and a bottom that is primarily mud and silt."

The probable causes for the reduction of suspended sediment load between the Pocatello and Tyhee gauges are irrigation water diversion dams and sediment deposition resulting from a decrease in river gradient between the two gauging stations. The diversion dams probably have a marked impact on sediment accumulation along the lower reaches of the Portneuf River, causing relatively large amounts of the fine-grained sediments to be deposited. The decrease in gradient is evident by the meandering nature of the Portneuf River along the lower reach, and fine-grained sediment deposition is more pronounced along the lower reaches of the Portneuf River, especially in the Fort Hall Bottoms, where spring high water will also erode sediments along the reservoir banks.

Some of the difference in the calculated sediment load between Pocatello and Tyhee could be due to the limited data available. Only 10 to 15 data points were collected for each station under a limited range of flow conditions which may not be representative of long-term conditions. The derived sediment load rating curves were extrapolated to determine the load for flows both higher and lower than the sediment sampling data. Given the large natural variability in suspended sediment data, the derived load estimates should be used only for crude comparisons.

The average annual sediment load from 1950 to 1989 for the Portneuf River at Pocatello was 54,500 T/yr, and for the Snake River at Blackfoot, 183,200 T/yr. The average annual flow for the same period for the Portneuf River at Pocatello was 310 cfs and 5,160 cfs for the Snake River at Blackfoot, Idaho. Further downstream on the Portneuf River at Tyhee, the average annual sediment load was 14,510 T/yr and the average flow was 516 cfs for the period from 1985 to 1990. Since the years of record for the Snake River and the Portneuf River at Tyhee gauges are not the same, their averages are not strictly comparable. A comparison of flows and sediment loads for a 3-year period for which records were available for both the Blackfoot and Tyhee gauging stations was therefore made to evaluate the representativeness of this analysis.

For the three years 1986 to 1988, the average annual load for the Snake River gauge was 178,500 T/yr, which is 97 percent of the 1950 to 1989 average of 183,200 T/yr. This indicates that the period from 1986 to 1988 is fairly representative of the long-term average with regard to sediment transport. The 1986-1988 average sediment load for the Portneuf River gauge at Tyhee was 16,250 T/yr. The 1986-1988 sediment load to American Falls Reservoir would therefore be 194,750 T/yr, with 8 percent supplied by the Portneuf River and 92 percent supplied by the Snake River. This corresponds closely to the proportion of average annual inflow to the reservoir for the same period, which is 9 percent (516 cfs) from the Portneuf River and 91 percent (5,160 cfs) from the Snake River. Thus, it appears that the long-term average contribution of the Portneuf to the sediment load in the American Falls Reservoir is less than 10 percent of the total.

3.2.2 EMF Facilities Hydrology and Drainage

Surface runoff within both the Simplot and FMC facilities is infrequent and is contained within the facilities. In this section, the term runoff is used to refer to rainwater that does not infiltrate at the point of contact with the ground, but rather is transported by overland flow to another location at the facilities. As discussed in Section 3.5, historic rainfall totals have not been particularly high. Consequently, when storm runoff does occur it does not actually run off the facilities but is contained in the storm drainage facilities, onsite ponds and depressions, for eventual use in plant operations, evaporation, or infiltration.

The site investigation found no channels by which stormwater would normally discharge from the FMC or the Simplot facilities, other than the NPDES-permitted IWW ditch outfall from the FMC property to the Portneuf River. The EMF facilities are separated from the Portneuf River by the Union Pacific Railroad and Highway 30. The bed of the railroad is raised above the terrain of the industrial areas and forms a barrier separating the plants from the river.

To evaluate the hydrologic response from more severe storm conditions, the maximum 24-hour storm of record (1.82 inches) was analyzed. Runoff from this storm would be completely contained on the site by the current drainage system. The hydrologic response to a 24-hour, 2-year storm (1.15 inches) was also analyzed to assess the ability of the FMC and Simplot drainage systems to contain stormwater under storm conditions. This storm was selected based on guidance from the Superfund Exposure Assessment Manual (EPA, 1988). Section 2.4 of the manual provides a method for quantitative analysis of surface water contamination. The recommended procedure is based on a calculation of the potential amount of contaminated soil transported by surface runoff releases from a site during an average storm. This analysis indicates that no surface water would be released during a 24-hour, 2-year storm at the EMF facilities. Thus, no contaminants would be released from unpermitted stormwater runoff.

For this analysis, the EMF study area was divided into seven major drainage areas based on the existing topography and drainage features. Several of these areas were further subdivided for the purpose of runoff calculation. Two of the areas are on the Simplot property, and five are on the FMC property (Figure 3.2-6). Each of these drainage areas is discussed in detail in the following subsections. The HEC-1 hydrologic simulation model was used to perform all runoff calculations.

3.2.2.1 Method of Analysis

Each drainage area described in this section was analyzed for runoff volume using the hydrologic simulation model HEC-1, developed by the U.S. Army Corps of Engineers (1990). The SCS curve number method was used to compute the rainfall excess for each watershed. The SCS curve number reflects the nonlinear relationship between rainfall excess and total storm depth; large storms have significantly larger runoff proportional to the rainfall than small storms. A detailed description of the SCS curve number method and how curve numbers were estimated is included in Appendix E.

The curve numbers used for the analysis are listed in Table 3.2-3. The curve number is related to the soil and cover condition of the watershed and was determined on the basis of observations conducted during the site reconnaissance in December 1992 and from the study of soil survey data obtained from the SCS.

The catchment areas were estimated by use of a planimeter and the site topographic maps prepared by Walker Associates (1992). Likewise, the capacities of ponding areas at FMC and the top of the Simplot gypsum stacks were estimated from the Walker maps. The estimated capacity of the other ponds at Simplot was provided by Simplot personnel.

Hydrographs of runoff were computed for each watershed using the SCS unit hydrograph method. This method requires a single parameter, the lag time, to define the distribution of runoff from a watershed in response to a unit of rainfall excess. The lag time was estimated as 0.6 times the travel time of the longest flow path in the watershed. The travel time was estimated from the length, slope, and roughness characteristics of watershed.

The seven separate drainage areas analyzed are described below and shown in Figure 3.2-6. The drainage area, curve number, and lag time for each area are presented in Table 3.2-3. Table 3.2-4 presents the results of the hydrologic analysis for the 2-year, 24-hour storm and maximum observed 24-hour storm scenarios.

3.2.2.2 Simplot

The natural drainage features of the Simplot property originally consisted of five small ephemeral stream gullies that combined and entered the Portneuf River near the I-86 bridge. The combined drainage area for the five gullies is 825 acres (335 hectares). The lower third of the gullies has been covered by Simplot's gypsum stacks. Runoff from the upper watershed of the gullies now flows to the top of the gypsum stacks.

The Simplot main plant covers the area from the gypsum stacks north to the UPRR. The bed of the railroad is higher than the adjacent plant area and forms a barrier that isolates surface water on the plant. Surface water potentially leaves the plant area via three routes: the main plant stormwater and noncontact water drainage line; the east drain; and a pipe which drains a small undeveloped containment area along the northeast boundary of the Simplot plant.

The main plant stormwater and noncontact water drainage line and the east drain flow into the water treatment pond system, just north of Highway 30. Water from the treatment system is then pumped across the Portneuf River to the surge pond for subsequent delivery to irrigators.

The small undeveloped containment area has a drainpipe (installed by UPRR) to the Portneuf River that serves as an overflow outlet in the unlikely event that the swale behind the railroad grade fills with runoff. Since this area is undeveloped and largely outside the Simplot property, it was not considered further in this analysis.

The following subsections describe the separate drainage areas on the Simplot property. The drainage area location map, Figure 3.2-6, shows their locations. Each area was modeled for a 24-hour, 2-year storm of 1.15 inches (3 cm) of rainfall and for the maximum 24-hour storm of record, 1.82 inches (4.6 cm). The results are included with the area descriptions.

Gypsum Stack Area (SIM1)

The area on top and above the gypsum stack forms an isolated drainage area indicated as SIM1 on the drainage area map (Figure 3.2-6). It includes the upper reaches of four small intermittent streams that drain onto the gypsum stack from the south. The total drainage area is about 825 acres (335 hectares).

Gypsum, a by-product of Simplot's manufacturing process, is pumped to the top of the gypsum stack as a gypsum water slurry. As the gypsum settles out of the slurry, the water evaporates or infiltrates through the gypsum stack. To prevent excess accumulation of water on top of the stack, four 18-inch (46 cm) diameter drain lines with 8-inch (20 cm) diameter standpipes collect seepage and decant ponded water from the stack. As the stack rises over time due to accumulation of gypsum, the drain lines are extended to the south, and additional standpipes are emplaced. Gypsum dikes, a minimum of 3 feet (0.9 m) high, surround the top of the gypsum stack and contain the slurry water and stormwater that accumulate on top of the gypsum stack.

Under normal operation, all water, including stormwater, that collects on top of the gypsum stacks either infiltrates, evaporates, hydrates with calcium and silica present in the waste facilities, or is collected by the drain lines for reuse in the plant or as slurry water. The drainlines discharge into a 10,000-gallon (38 cubic meter) decant tank on the lower, northernmost gypsum stack. A 24-inch (61 cm) high-density polyethylene (HDPE) pipe conveys water from the decant tank to the process sump.

The native soils in this drainage are largely silt loams of hydrologic soil group B. Plant personnel have never observed rainwater running off of the gypsum stack, indicating that it also has a low curve number. A curve number was estimated as 75.

To test the ability of the gypsum stack to contain storm runoff, an estimate of the storm runoff was calculated using the HEC-1 model. From the maximum 24-hour storm of record, the total runoff was estimated to be 6.70 million gallons (MG) (25,360 cubic meters). The total runoff ponding on the gypsum stacks from a 24-hour, 2-year storm was estimated to be 1.30 MG (4,920 cubic meters). The ponded water would accumulate in three separate areas: the lower northernmost gypsum stack, and the eastern and western halves of the upper gypsum stack, which are separated by a dike. The combined storage capacity of the gypsum stacks is 125 MG (473,100 cubic meters), well in excess of what is needed to contain the runoff.

The analysis indicates that the drainage areas on top of the gypsum stacks can contain the runoff from both a 24-hour, 2-year storm and the historic maximum 24-hour rainstorm. The analysis was based on existing topography as presented in the Walker maps of August 1992. In the future, the configuration of the gypsum stack and dike could change as additional gypsum accumulates.

Main Plant Area (SIM2)

The drainage area around the Simplot main plant, designated SIM2 in Figure 3.2-6, extends from approximately the property boundary bordering FMC on the west, to the UPRR on the north, to the dike on top of the gypsum stacks on the south, and the lower gypsum stack on the east. This area was further subdivided into five sub drainages, as listed in Table 3.2-3, for analysis. The combined drainage area is 185 acres.

The southern portion of this area (subdrainage PTB) encompasses most of the north flank of the gypsum stacks and a small portion of the FMC facility adjacent to the IWW pond. The curve number for this area was estimated to be 73. Runoff is directed to sewer inlets and conveyed by branch sewer lines to the 32-inch (81-cm) HDPE main plant drainage line running from south to north through the center of the main plant area. A 30-inch (76-cm) culvert conveys the water under the railroad and highway to a pipe leading to the holding pond within the water treatment pond system. Drainage from around the main plant facilities (subdrainage plant) is also collected by the plant drainage line. The curve number for the plant area was estimated to be 93.

Most of the eastern portion of the area (subdrainages ROAD and OGS) drains into an area contained by a new stormwater containment berm which provides a storage capacity of 1.5 MG (5,700 cubic meters). This area includes portions of the slopes of the gypsum stacks and was estimated to have a curve number of 75. An area (subdrainage PSA) of approximately 10 acres (4 hectares) is not contained by this berm but drains to the process sump. Its curve number was estimated to be 80. The sump combines decant water from the gypsum stack, reclaimed wastewater, and storm runoff. Up to 35,000 gpm (2.20 cubic meters per second) are regularly pumped from the sump back into the phosphoric acid production process. Additional capacity exists to pump up to 6,000 gpm (0.4 cubic meter per second) of slurry or water from the sump to the ponds on top of the upper gypsum stack. Overflow from the sump would flow to a newly constructed lined pond which has replaced (and which is adjacent to) the former east overflow pond, via a 24-inch (61-cm) HDPE pipe.

The pond that has replaced the former east overflow pond, besides receiving overflow from the sump, collects some local surface runoff from the area between the lower gypsum stack and the Union Pacific Railroad. The pond has a capacity of approximately 1 MG (3,800 cubic meters). Overflow from the pond is conveyed by the east drain, a 24-inch HDPE pipe, under the railroad to the holding pond within the water treatment pond system.

Water from the 1.25 MG (4,700 cubic meters) capacity holding pond is released to the 1.25 MG (1,500 cubic meters) equalization pond after treatment, then pumped to the 13 MG (49,000 cubic meters) surge pond north of the Portneuf River. The maximum pumping capacity is 1,800 gpm (6.8 cubic meters per second).

During a storm equivalent to the maximum historic 24-hour storm, the peak flow of runoff from the plant area tributary to the main plant drainage culvert was estimated to be 31,000 gpm (1.9 cubic meters per second), including 350 gpm (0.02 cubic meter per second) of normal process water. This is well below the culvert's capacity of 60,000 gpm (3.78 cubic meters per second). There would be no flow through the east drain. The total volume of storm runoff conveyed to the holding pond would be 2.51 MG (9,500 cubic meters), of which 1.62 MG (6,100 cubic meters) would be pumped to the surge pond during the storm. Therefore, no stormwater would be released to the river.

Portneuf River Floodplain

An attempt was made to investigate the location of the plant with respect to the 100-year floodplain of the Portneuf River as designated by the National Flood Insurance Program. This program, part of the Federal Insurance Administration, publishes maps of select regions of the United States designating 100-year and 500-year flood boundaries. Flood insurance rate maps for both Bannock County and the City of Pocatello, Idaho, were reviewed; no studies were conducted for Power County. Neither of the studies reviewed encompassed the Portneuf River in the EMF study area.

3.2.2.3 FMC

The original drainage at FMC has been significantly modified by the placement of slag piles and holding ponds at the facility. In general, the FMC property is now highly compartmented with respect to the handling of stormwater. There are parts of five separate drainage areas on the property, separated by natural ridges, slag piles, and dikes.

In addition to the five main drainage areas, there are several process water storage ponds on the site with a minimum of 2 feet (0.6 m) of freeboard. The ponds are contained by dikes rising well above the surrounding terrain and are not subject to runon from other areas. The freeboard of 2 feet (0.6 m) is more than adequate to contain rainfall in these ponds for a storm of less than 2 inches (5 cm).

The following subsections describe the separate drainage areas on the FMC property (Figure 3.2-6). Each area was modeled for a 24-hour, 2-year storm of 1.15 inches (3 cm) and for the historical maximum 24-hour storm of 1.82 inches (4.6 cm). The results are included with the area description and in Table 3.2-4.

Drainage Area FMC1

This area includes the IWW basin, and is bounded by the east slope of the slag piles, the west slope of the Simplot gypsum stack, and extends south to a natural ridge approximately 1 mile (1.6 km) south of the FMC plant buildings. The total drainage area is about 114 acres (46 hectares).

The capacity of the 12-inch (30 cm) IWW discharge pipe was estimated as 2,150 gpm (0.14 cubic meter per second), slightly more than the maximum historical monthly average flow of 2,130 gpm (0.13 cubic meter per second) recorded by FMC in March 1993.

The native soils in this area is silt loam, classified as hydrologic soil group B by the SCS. These are overlain by coarse slag and ore stockpiles in some areas. A curve number of 71 was estimated.

There are two places where water ponds onsite in this area, in a depression adjacent to the plant haul road and adjacent to the main plant ore stockpile. The ponding storage capacity of these are, respectively, 1.1 MG (4,200 cubic meters) and 0.95 MG (3,600 cubic meters). The maximum historic storm would produce only 0.6 MG (2,300 cubic meters) of runoff; therefore all runoff would be contained onsite. The 2-year storm would produce only 0.1 MG (380 cubic meters) of runoff.

Drainage Area FMC2

This area consists of the slag pit and the slag piles immediately to the south. The total drainage area is 94 acres (38 hectares). The soils are silt loam covered by coarse slag; a curve number of 71 was estimated. Runoff from this area would flow down to the slag pit just south of FMC's furnace building. A total of 0.51 MG (1,930 cubic meters) would result from the maximum historic storm, and a total of 0.08 MG (340 cubic meters) of runoff would result from a 24-hour, 2-year storm. The slag pit has a storage capacity of 5.7 MG (22,000 cubic meters), well in excess of the total runoff. Therefore, no releases from this area could occur.

Drainage Area FMC3

This area consists of the main plant area, excluding the western portion of the employee parking lot, which is served by storm sewers.

The total drainage area of 28.5 acres (11.5 hectares) is substantially covered by parking lots and buildings. A curve number of 93 was estimated based on the SCS recommendation for industrial facilities.

The railroad swale, which receives the runoff from the area around the plant buildings, is a long, narrow depression about 30 feet (9 m) wide and 1,000 feet (300 m) long. While it is about 8 feet (2.5 m) deep at its western end, near the plant headquarters, the ground level above the swale slopes downward to the east so that it is about only 2 feet (0.6 m) deep at its east end. The storage volume is about 0.6 MG (2,300 cubic meters).

The runoff volume from the maximum historic 24-hour storm was estimated to be 0.89 MG (3,400 cubic meters) and from a 24-hour, 2-year storm, runoff was estimated to be 0.44 MG (1,700 cubic meters). Overflow from the railroad swale would flow onto the Simplot facility and be captured by the Simplot plant sewer. This overflow was included in the calculation of runoff discussed above for area SIM1. Such an overflow has never been observed to actually occur according to both Simplot and FMC personnel.

Drainage Area FMC4

This area consists of a small valley south of the slag pile that surrounds FMC's landfill. The valley extends 1.2 miles (1.9 km) south to a ridge in the Bannock Hills. The watershed is about 485 acres (195 hectares) in area and, south of the landfill, it remains undeveloped. The area is predominantly covered by silt loam soils, with some rocky slopes at the higher elevations. A curve number of 80 was estimated.

The southwestern two-thirds of the basin are outside of the FMC property boundary. The slag pile completely fills the bottom of the north end of the valley, effectively blocking the flow of surface water. At the lowest point in the valley, the top of the slag pile is at elevation 4,588 feet (1,398 m) above MSL, whereas the valley floor is at 4,550 feet (1,387 m) above MSL. Thus, a 38-foot-deep (12-m-deep) depression is formed behind the slag pile. The storage capacity of this depression was estimated to be 54.7 MG (207,000 cubic meters).

The total runoff volume from the maximum historic 24-hour storm was estimated to be 6.0 MG (2,300 cubic meters) and from a 24-hour, 2-year storm, 1.7 MG (6,400 cubic meters). Therefore, no releases would result.

Drainage Area FMC5

This area consists of all FMC property west of the main plant area and slag piles. It includes the Bannock Paving facility, the western side of the slag piles, the western portion of the employee parking lot, and the undeveloped land west of the main FMC plant bounded roughly by Michaud Creek on the west, Taghee ditch on the north, and the south entrance road. The total drainage area within the FMC property is about 1,200 acres (480 hectares).

Site topography indicates that storm runoff in this area drains to the west to the undeveloped land just west of FMC's Ponds 9E and 15S. A depression is formed bounded by the foot of the Bannock Hills on the south, the elevated Taghee Canal and UPRR bed on the north. The ground rises gradually to the east and west. The total area of the depression is about 248 acres (100 hectares). At its lowest point, it is 9 feet (2.7 m) below the embankment of the UPRR and the Taghee Canal. The total volume of the depression is about 463 MG (1,750,000 cubic meters).

For the purpose of hydrologic modeling, drainage area FMC5 was divided into three subdrainages: Michaud, Bannock, and Local, as listed in Table 3.2-3. The Bannock subdrainage encompasses the Bannock Paving area and some surrounding areas, including about one-half of the employee parking lot. The curve number for the Bannock area was estimated to be 90. The Local area represents the remaining land within the FMC facilities, including the large, predominantly undeveloped field west of the operating area. The curve number was estimated to be 71. The Michaud area represents all of the Michaud Creek drainage, which is discussed below.

The runoff from the Bannock and Local areas was estimated using the HEC-1 model. Runoff from the maximum historic 24-hour storm was estimated to be 8.7 MG (33,000 cubic meters), well below the capacity of the depression. The ponded area is indicated in Figure 3.2-6. For the 24-hour, 2-year storm, the runoff volume was estimated to be 1.96 MG (7,400 cubic meters).

Just west of the FMC property boundary is Michaud Creek, an ephemeral stream that, when flowing, is captured by the Taghee Canal. Between the mouth of the valley where Michaud Creek flows north, out of the foothills, to the Taghee Canal, the creek crosses an alluvial fan formed from deposited sediment. The alluvial fan and stream channel are at a higher elevation than the FMC facility, and, therefore, runoff from the plant is blocked from reaching the stream. However, floodwaters from Michaud Creek could overflow the banks and cause flooding at FMC, leading to stormwater releases.

To investigate this scenario, Michaud Creek was included in the model of the western portion of the FMC facility. The stream valley is 7,488 acres (3,030 hectares) in area. It is entirely undeveloped rangeland with silt loam soils which belong to hydrologic group B. A curve number of 71 was estimated.

Flooding of a stream on an alluvial fan is highly unpredictable, and could flow in any direction from the valley mouth. The most conservative assumption is that after exceeding the capacity of Taghee Canal, the remainder of Michaud Creek would flow toward FMC.

For the maximum historical 24-hour storm, the runoff from Michaud Creek was estimated to be 40.7 MG (154,000 cubic meters). Combined with the flow from FMC, the total runoff would be 46.6 MG (187,000 cubic meters), well below the storage capacity of the depression. For the 2-year, 24-hour storm, a total of 4.56 MG (17,200 cubic meters) of runoff would result from Michaud Creek. Combined with the flow from FMC, the peak storage in the west field depression would be 6.52 MG (24,700 cubic meters).

3.4 STUDY AREA SOILS

This section describes the origin of soils in the EMF study area and their geographical distribution (Section 3.4.1), hydraulic properties (Section 3.4.2), and mineralogical and geochemical properties (Section 3.4.3). Soil descriptions and distribution are based primarily on SCS surveys for the Fort Hall area and Bannock County. Different portions of the facilities fall within the Fort Hall and Bannock County surveys. An overview of study area soils is presented in Figure 3.4-1.

The origin of each soil type is important in determining the properties of the soil. Soils in the EMF study area originate from deposition by rivers and streams (alluvium), collection at the base of slopes (colluvium), weathering in place (residuum), and deposition by wind (loess).

In general, the southern portion of the FMC facility is situated on silty soils primarily derived from loess and colluvium. The soils in the northern portion of the FMC facility are derived primarily from loess and deposits of silty sand and gravel (alluvium). The soils in the southern portion of the Simplot facility are less consistent; the soils in the southwestern area consist of nearly homogeneous silt (loess and silty colluvium), while soils in the southeastern area are more variable and include alluvium, colluvium, and residuum. The soils in the northern portion of the Simplot facility consist primarily of sandy gravels (alluvium) in the central part, with silty soils (loess and fine-grained alluvium) on the east and west.

In terms of hydrogeological properties, study area soils, which consist primarily of silt (loess and some fine-grained colluvium and alluvium), have relatively lower permeability than other soil types. Alluvial soils generally are coarser grained, with correspondingly greater hydraulic conductivity. Alluvial soils also generally have greater hydraulic conductivity in the horizontal direction than in the vertical direction due to the "bedded" nature of their deposition. Hydraulic conductivity of colluvium and residuum is variable, depending on grain size and weathering characteristics of their source materials.

Geochemical characteristics of the soils are a function of the source materials. In general, native soils in the area around Pocatello are alkaline; that is, their pH is greater than 7. This is significant, as alkaline soils tend to retain metals and attenuate their migration (leaching) through the soil horizons to the groundwater (i.e., the greater the soil's alkalinity, the greater the soil's ability to retard migration of the metal ions).

SOIL TYPES (SECTION 3.4.1):	• EMF study area soil descriptions and distribution based on the SCS surveys for the Fort Hall area and Bannock County. • In major portions of both facilities, naturally occurring soils have been modified by mixing with other soils or by-products, or by placement of fill materials (such as slag) over them. • Soil types for both facilities are as follows: Simplot: Sandy gravels (alluvium) in central part; silty soils (loess and fine-grained alluvium) on the east and west — FMC: Loess and alluvial deposits Simplot: Homogenous silt (loess and silty alluvium) to the west; more variable (alluvium, colluvium, and residuum) to the east — FMC: Silty soil derived primarily from loess and colluvium
HYDRAULIC PROPERTIES (SECTION 3.4.2):	• Homogenous silt has relatively lower permeability when compared with other study area soil types. • Alluvial soil has greater hydraulic conductivity in the horizontal direction than the vertical. • Other study area soil types are more variable in permeability.
MINERALOGY AND GEOCHEMICAL PROPERTIES (SECTION 3.4.3):	• Under alkaline soil conditions, inorganic chemicals are likely to precipitate and/or adsorb onto soil particles, yielding low poor water concentrations, and, hence, low bioavailability to human and ecological receptors, including plants. • Native soils are generally alkaline due to their calcareous nature.

FIGURE 3.4-1
OVERVIEW OF STUDY AREA SOILS

3.4.1 SOIL TYPES

Soils in the Fort Hall area and Bannock County have been surveyed by the SCS as part of its nationwide soil mapping and classification program. In the SCS surveys, the soil profile is described as extending from the surface down into the underlying unconsolidated material. The underlying unconsolidated material is defined as a region devoid of plant roots, burrowing macroinvertebrates, and microbiological activity. Further, its mineral structure has not been altered by biological activity. In the EMF study area, the underlying unconsolidated materials region begins approximately 2 feet beneath the soil surface.

It should be noted that the soil associations shown in the general soil map for the Fort Hall area soil survey (SCS, 1977) and the Bannock County soil survey (SCS, 1987b) do not entirely match where the survey areas overlap. Differences in soil names from one area to the next are partly a function of the differences in soil patterns and associations, and partly a function of the naming conventions used by SCS personnel. The two soil surveys were conducted nearly 10 years apart.

The major soil associations in the EMF study area that were identified in these two soil surveys are shown in Figure 2.2-3. A soil association consists of one or more major soil types and at least one minor soil type; the soil association is named for the major soils. The soils in one association may occur in another, but in different combinations. The soil associations identified in the Fort Hall area of the EMF study area are Snake-Philbon, Paniogue-Declo, Paniogue-Broncho, and Pocatello-Wheeler-Portneuf. Soil associations in the Bannock County portion of the EMF study area are the Inkom-Joesvar, Arimo-Downey-Bahem, Ririe-Rexburg-Lanoak, and Camelback-Hades-Valmar. Table 3.4-1 summarizes the general characteristics of individual soils within these soil associations. Properties of the soil associations are summarized in Table 2.2-2.

The major portion of the FMC facility is in an area of occurrence of the Pocatello-Wheeler-Portneuf soil association. These soils are described as silt loams, formed primarily in loess (material transported and deposited by wind and consisting of primarily silt-sized particles). The northern portion of the FMC facility extends into an area of the Paniogue-Declo association. These soils are more variable, ranging from gravelly coarse sand to silt loam, developed primarily from alluvial fans and terraces, which accounts for their greater range of particle size and permeability.

Except for the western and southern portions of the FMC facility, these naturally occurring soils have been modified either by mixing with other soils and by-products (such as slag), or by placing slag or other fill materials over them to provide level foundations for facility structures, improve drainage, to provide roads for access, or embankments for ponds.

The southern portion of the Simplot facility is divided between the Ririe-Rexburg-Lanoak (RRL) and the Camelback-Hades-Valmar (CHV) soil associations. The RRL soils are very deep silt loams formed in loess, and are similar to the Pocatello-Wheeler-Portneuf soils. The CHV soils are more variable, ranging in texture from gravelly silt loams to extremely stony silt loams formed in alluvium, colluvium, and residuum.

The northern portion of the Simplot facility extends into the Arimo-Downey-Bahem (ADB) soils and the northeastern corner extends into Inkom-Joesvar (IJ) soils. The ADB soils formed in loess and silty alluvium. This soil association is similar to Paniogue-Declo soils, which occupy a small portion of the northwestern corner of the Simplot facility. Inkom-Joesvar soils are deep, moderately well-drained soils that formed in silty alluvium. Inkom-Joesvar soils occur along the Portneuf River.

Within portions of the Simplot facility, the naturally occurring soils have been modified either by mixing with other soils and by-products (such as gravels and gypsum), or by placing other fill materials over them to provide level foundations for facility structures, improve drainage gradients, or to provide roads for access or embankments for ponds.

3.4.2 HYDRAULIC PROPERTIES

Soil hydraulic properties control the movement of water through the soils, both laterally and vertically. The hydraulic conductivity (permeability) of a soil is a measure of its ability to transmit water through the soil profile. The hydraulic conductivity usually varies with depth within the soil column, as well as laterally with variations in grain size and compaction of the soil.

Most of the study area soils are formed from materials derived from wind-blown (aeolian) or alluvial deposition. On the slopes of the Bannock Hills, some of the soils are derived from colluvium or are residual (formed in place). The depositional process for alluvial deposits results in a “bedded” and "graded" character, which imparts a strong anisotropy to their hydraulic conductivity, especially over large areas. Alluvial deposits tend to vary more widely in hydraulic conductivity than do aeolian materials, typically by two to three orders of magnitude (Freeze and Cherry, 1979). The wide range of hydraulic conductivity reflects the range of the grain-size distribution within the deposit.

In comparison with the alluvial deposits in the study area, aeolian silts (loess) are less permeable and more isotropic in nature, although fractures, root channels, and animal burrows can cause secondary permeability that can greatly exceed the primary permeability of the original soil mass. Typical hydraulic conductivities for unconsolidated soils in the vicinity of the EMF facilities range from about 4×10^{-4} cm /sec for fine-grained soils (silty clays) to greater than 10^{-2} cm/sec for coarse-grained soils (sandy gravels). Typical soil porosities range from 35 to 70 percent for silts and clays, to 25 to 50 percent for sands and gravels (Freeze and Cherry, 1979).

3.4.3 MINERALOGY AND GEOCHEMICAL PROPERTIES

Soil mineralogy constitutes an important determinant of potential exposure to both human and ecological receptors since only the soluble fraction of an inorganic chemical is typically bioavailable. Bioavailability refers to that fraction of an inorganic which is available for absorption. In soils, the speciation and solubility of metals and trace elements determine the bioavailability of an inorganic and are controlled to a large degree by the soil mineralogy. For example, inorganics may be associated with poorly soluble minerals that are far less likely to dissolve in the gastro-intestinal tract than soluble salts. Alternatively, some inorganics may be encapsulated or coated with other less soluble minerals, further reducing the bioavailability of the inorganic constituents (Davis et al., 1992).

Similarly, mineralogy is also an important determinant of plant root uptake of inorganics from soils. Since plants absorb inorganics primarily from soil pore-water, the solubility of the inorganic in the soil matrix determines the inorganic's bioavailability for plant uptake (Barber, 1984). Inorganic chemical concentrations in soil solution are controlled by solution/precipitation, adsorption/desorption, and ion exchange equilibria (Sposito, 1980).

Under alkaline soil conditions, which exist in study area soils, inorganic chemicals, especially metals, are likely to precipitate and/or adsorb onto soil particles, yielding low pore-water concentrations and, hence, low bioavailability to both humans and ecological receptors, including plants (Sposito, 1980). For example, due to the alkaline and calcareous nature of the study area soils, arsenic may be present primarily in calcium arsenate, enargite, tennantite, arsenopyrite, copper-lead-arsenic oxides and iron-arsenic oxides, and other poorly soluble minerals (Sadiq, 1981; Davis et al., 1992). Soil mineralogical studies were undertaken as described in Section 2.7. Results are reported in Section 4.6.

The native soils in the EMF study area are generally alkaline (pH >7) because of their calcareous nature. This is consistent with most soils in the more arid regions of the western United States (Foth and Turk, 1972). The alkaline pH and calcareous nature of these soils minimize leaching of most metals, because the mobility of most of the metals is closely correlated with soil pH.

Table 3.4-1 includes geochemical data from the SCS soil surveys for the soil associations which occur in the EMF study area. It also provides estimates of texture, permeability, and other general soil properties.

3.7 ECOLOGICAL CHARACTERIZATION

The ecological characterization described below provides a context in which to place the biological resources in the EMF study area. A summary of the terrestrial and aquatic ecosystems presented in this section focuses on important habitats and species occurring or potentially occurring in the study area. Section 3.7.1 describes important habitats and species in the terrestrial ecosystem, as well as the potential occurrence of federal and state protected species. Section 3.7.2 describes the aquatic ecosystem of the Portneuf River (the portion of the river that is in the EMF study area), and includes discussions on important habitats and sensitive species. An overview of this section is presented in Figure 3.7-1.

3.7.1 TERRESTRIAL ECOSYSTEMS

Major terrestrial vegetation cover types and wildlife habitats in the EMF study area include–in order of areal extent–agriculture, sagebrush steppe, and wetland/riparian. The remainder of the study area is in residential, industrial, and commercial development. The EMF facilities were originally in sagebrush steppe but are now largely disturbed and provide limited wildlife habitat. The Portneuf River is the major aquatic ecosystem in the EMF study area although the water quality is affected by anthropogenic influences from various sources along the Portneuf River within the city limits of Pocatello. No critical habitat of threatened or endangered plant or animal species is known to occur in the EMF facilities area.

Sensitive wildlife species (defined as species provided federal protection such as threatened or endangered species, migratory waterfowl, raptors [birds of prey], or, candidates for listing as threatened or endangered or species directly in the human food chain) known to occur in the study area include waterfowl (ducks and geese), white-tailed deer and mule deer, and upland game birds. Bald eagles may occasionally use habitats along the Portneuf River for hunting, and peregrine falcons are known to migrate through the study area. Several species of raptors also hunt and nest in the study area. Golden eagles have been observed nesting in undisturbed cliff habitat on the southern edge of the EMF facilities area.

TERRESTRIAL ECOSYSTEMS (SECTION 3.7.1):	• Major terrestrial vegetation cover types and wildlife habitats in the EMF study area include agriculture, sagebrush steppe, and wetland/riparian, as shown in Figure 3.7-2. • Wildlife habitats in the vicinity of the EMF facilities include: sagebrush steppe, grassland, riparian, cliff, and juniper woodland. • No critical habitats for threatened or endangered species, or special habitats, occur in the study area.
AQUATIC ECOSYSTEMS *(SECTION 3.7.2):*	• The most significant aquatic habitats in the immediate vicinity of the EMF facilities are the Portneuf River and associated springs. The Portneuf River flows to the American Falls Reservoir. River water quality is reduced by numerous point and nonpoint sources discharging to the river above and below the EMF facilities. • Sightings of several endangered or threatened species, or candidate species have been reported in the Fort Hall Bottoms. • A number of important aquatic species and habitats are present in the study area (Section 3.7.2.3).

FIGURE 3.7-1
OVERVIEW OF ECOLOGICAL CHARACTERIZATION

3.7.1.1 Vegetation Cover Types and Wildlife Habitats

The EMF facilities are approximately 5 miles (8 km) southeast of the American Falls Reservoir, part of the Minidoka Wildlife Refuge System, and about 4 miles (6.4 km) south of the riparian/wetland-dominated floodplains at the mouths of the Portneuf and Snake Rivers (Fort Hall Bottoms). At higher elevations, 5,000 feet (1,524 m) to the south and west of the EMF facilities, Utah juniper woodland dominates the Bannock Range with pockets of aspen (*Populus tremuloides*), snowberry (*Symphoricarpus sp.*), and mountain mahogany (*Cerocarpus montanus*) in the draws. Sagebrush steppe occurs at lower elevations extending to the American Falls Reservoir.

The EMF study area includes urban (Chubbuck and Pocatello) and agricultural areas, as well as rangeland within the Fort Hall Indian Reservation and BLM lands. Major vegetation cover and wildlife habitat types existing in the study area include sagebrush steppe, riparian/wetlands, agriculture, and disturbed/urban areas. In addition, cliffs to the south of the EMF facilities provide cliff/cave habitats for some wildlife species, as described later in this section. Figure 3.7-2 shows the geographical distribution of the major vegetation cover types and associated wildlife habitats identified in the EMF study area, and Table 3.7-1 shows the total associated acreages. The vegetation and habitats are described briefly below.

Sagebrush Steppe

Sagebrush steppe vegetation occurs at elevations below 6,622 feet (2,019 m) on the Bannock Mountains to the anthropogenically undisturbed alluvial plain of the Portneuf River. This vegetation type covers 34 percent (6,139 acres/2,485 ha) of the area within a three-mile radius of the facilities. In addition, most of the Fort Hall Indian Reservation portion of the study area is in this vegetation type. Species of this vegetation type include big sagebrush (*Artemisia tridentata*), rabbit brush (*Chrysothamnous nauseosus*), Antelope bitterbrush (*Purshia tridentata*), arrow leaf balsamroot, tapertip hawksbeard, and bunch grasses including bluebunch grass (*Agropyron spicatum*), western wheat grass (*Agropyron smithii*), Indian rice grass (*Oryzopsis hymenoides*), needle-and-thread (*Stipa comata*), Idaho fescue (*Festuca idahoensis*), and squirreltail (*Sitanion hysterix*) (Cronquist et al., 1972). Other grasses include Nevada bluegrass, prairie junegrass, Sandberg bluegrass, and slender wheatgrass (SCS, 1987). The BLM land in the southern portion of the EMF study area and Fort Hall Indian Reservation lands to the south and west are in sagebrush steppe.

At elevations above 6,622 feet (2,019 m), and to the south of the FMC and Simplot facilities, Utah juniper (*Juniperus osteosperma*, a dominant of juniper woodland) intergrades along the sides of draws with the sagebrush-dominated slopes. Bitterbrush provides browse for mule deer (*Odocoileus hemionus*) in this area.

In addition to wildlife habitat, this vegetation type has continued to be used as rangeland for cattle grazing, both on the BLM land and Fort Hall Indian Reservation (Hogander, 1992).

Vertebrate species expected or observed in this habitat include shrews, sagebrush voles, deer mice, pocket mice, weasels, mule deer, hawks, owls, shrikes, kingbirds, sparrows, spadefoot toads, tiger salamander, and lizards. The population density of some species is expected to decrease with distance from the primary water source, the Portneuf River.

Riparian/Wetlands

Riparian/wetland vegetation in the EMF study area occurs along portions of Michaud Creek, the Portneuf River, and in association with springs and seeps, gravel and borrow areas, and irrigation canals. This vegetation type makes up 3 percent (597 acres/242 ha) of vegetation/habitats within a three-mile radius of the EMF facilities in the study area. Locations of wetlands and riparian habitats identified on U.S. Fish and Wildlife Service (U.S. FWS) wetland inventory maps (U.S. FWS, 1980) are shown in Figure 3.7-2.

Wetlands provide a variety of functions. Major categories of wetland functions (Sather and Smith, 1984) relating to key functions in the EMF study area include the following:

- Sediment entrapment — This is an important function because it removes pollutants and sediments from moving waters.
- Nutrient retention and removal — The nutrient retention and removal function of wetlands involves the uptake or storage and modification of nutrients, especially nitrogen and phosphorus, in vegetation or the substrate.
- Food chain support/nutrient export — Food chain support refers to the function of removing nutrients and making them available to autotrophic (plants) consumers and a variety of heterotrophic (animal) consumers.
- Fisheries habitat — Major factors influencing value of fisheries habitat include physical and chemical water quality and quantity including hydroperiod, flow and depth, and cover substrate and interspersion. Freshwater fisheries are primarily influenced by temperature and dissolved oxygen, with turbidity, alkalinity, and pH also being important. Cover refers to areas used by fish for protection from predators and climatic conditions, and substrate for feeding and reproduction. Interspersion refers to the relationship between open water and vegetation, types of vegetation, and various substrates.
- Wildlife habitat — Wildlife habitat value is based upon structure and species diversity of the vegetation, surrounding land uses, spatial patterns within and between wetlands, vertical and horizontal zonation, size, and water chemistry.
- Socioeconomic values — Socioeconomic values include those that provide direct and indirect social and economic benefits such as recreation, hunting, and aesthetics.
- Flood control — Factors affecting flood control include size, location within the drainage basin, texture of substrate, and lifeform of wetland vegetation.
- Shoreline anchoring — Factors influencing anchoring include type of vegetation that binds and stabilizes substrates and dissipates wave and current energy.
- Groundwater discharge and recharge — Factors affecting discharge and recharge are the nature of substrate, water permanence, the nature of surface outlets and amount of edge, type, and amount of vegetation.

- Disruption of erosive forces — Control of erosion depends upon vegetation, plant species involved, width of vegetated shoreline band, efficiency of vegetated band to soil composition, height and slope of bank, and elevation of the toe of the bank with respect to mean storm high water.

General evaluation of wetland functions and data collection during the Phase I fall (September 1992) reconnaissance focused on fisheries and wildlife habitats and socioeconomic values of hunting.

Michaud Creek. The portion of Michaud Creek in the EMF study area is intermittent, with riparian vegetation forming a corridor along the creek. Also, five wetland areas, as delineated on U.S. FWS wetland inventory maps (1980), occur along Michaud Creek (Figure 3.7-2). These include three riverine open water perennial wetlands, in Sections 22 and 23 (T6S, R33E), a palustrine (marshy) emergent, seasonally persistent excavated wetland in Section 15 (T6S, R33E), and a palustrine wetland associated with an impounded area on the creek in Section 22 (T6S, R33E).

During field reconnaissance, prevalent tree species found along the creek included peachleaf willows (*Salix lasidandra*), alder (*Alnus tenufolia*), and cottonwood (*Populus angustifolia*). At the lower reach near Taghee lateral, Siberean elm, an introduced species, also occurred. Understory shrub vegetation included coyote willow (*Salix exigua*), rose (*Rosa sp.*), red-osier dogwood (*Cornus stolonifera)*, chokecherry (*Prunnus virginnia*), and currant (*Ribes sp.*). Grasses and weedy species in the herbaceous layer included bluebunch wheatgrass, slender wheatgrass, bluegrass (*Poa palustris.*), cheatgrass (*Bromus tectorum*), annual sunflower (*Helianthus annulus*), Russian thistles (*Salsola kali*), and other species such as balsam root (*Balsamorhiza sogittata*) and lamb's-quarters (*Chenopodium alba*). Adjacent land use is cattle grazing. Cattle grazing also occurs in the riparian vegetation along the creek. Stresses on vegetation due to grazing effects, such as trampling of understory vegetation and soils, and compacted soils and grazing lines on trees and shrubs, were evident. No other stresses on vegetation were noted.

The riparian vegetation and isolated wetlands along the creek provide a wildlife habitat. Riparian vegetation along the creek is important to wildlife in the adjacent sagebrush steppe habitat; it serves as a food and water source, as well as provides cover. Palustrine wetland areas on the creek are mostly associated with man-made impoundments near livestock pens and farmhouses. Species found in these wetlands include cattails, willows, sedges, smartweed, and mint.

Portneuf River. The most important wetlands in the EMF study area occur along the Portneuf River, from the end of channelization in the City of Pocatello, through the Portneuf River floodplain on the Fort Hall Indian Reservation to the American Falls Reservoir. The wetlands along this portion of the river vary in width from an estimated few feet up to approximately 100 feet (30.5 m) in some areas. These wetlands provide habitat, food sources, and resting areas for a variety of wildlife species, such as beavers, ducks, geese, and waterbirds. They also probably provide some sediment trapping, nutrient retention, and cycling functions within the ecosystem. Sediment samples were collected in July and August 1992 at 24 sites along the river. Characterizations of these sites are contained in Section 3.7.2. An additional four sites were sampled in October 1992 downstream from river mile 10, and two additional sites between sampling points 23 and 22 upstream of the facility.

A variety of wetland and riparian vegetation occurs along the river, depending upon water and soil saturation conditions. The majority of these wetlands delineated by the U.S. FWS (1980) include riparian scrub shrub, and both deciduous and palustrine emergent vegetation.

The riparian vegetation along the river, including the riparian scrub shrub deciduous wetlands, is adapted to soil conditions that are saturated at least a portion of the year. This vegetation is well-developed and extends from the edges of the river to the drier uplands. The tree layer that occurs intermittently with an open canopy below Batiste Road is composed of peachleaf willow with a dense shrub understory. Shrub understory species are the most prevalent. The shrub understory is made up of coyote willows and other shrubs such as red-osier dogwood, rose, alder, currant, and chokecherry. Where the shrub layer is more open, grasses and herbaceous species occur including numerous grasses, such as bluegrass, bromes, and grasslike sedges, and dandelion (*Taraxacum offinale*). Above Batiste Road, the tree canopy is closed with mature peachleaf willows and alder up to 20 feet (6 m) high. The understory is dominated by grasses and herbs including bluegrass (*Poa sp.*) and sedges (*Carex*), bluebells (*Mertensia sp.*), starry solomon-plume (*Smilacina stellata*), bedstraw (*Galium trifolium*), lamb's-quarters (*Chenopodium alba*), clover (*Trifolium sp.*), and cow parsnip (*Heracleum lanatum*). Cover varies, based on ocular estimates, from 90 to 100 percent. No evidence of stresses on riparian vegetation (chlorotic conditions or lesions) was noted. Species composition along the river (from water quality stations 24 to 1) varies according to the amount of man-made disturbants and river flow conditions, which would be expected.

Palustrine wetlands along the river (Figure 3.7-2) are present where the soil is saturated most of the time. Species found in these wetlands include cattails, willows, sedges, smartweed (*Polygonum sp.*), and mint (*Mentha sp.*).

The Portneuf wetlands provide habitat, food sources, and resting area for a variety of wildlife species, such as beavers, ducks, geese, and waterfowl. The northern area of the American Falls Reservoir, including the mouths of the Portneuf and Snake rivers (Portneuf and Fort Halls Bottoms), provides habitat for overwintering and nesting of a variety of migratory species, including waterfowl shorebirds, waterbirds, and special status species, such as the bald eagle and trumpeter swan. In an arid environment where water is a limiting factor, such as in the vicinity of the EMF facilities, open water is attractive to a variety of wildlife, especially migratory waterfowl.

Other Wetlands. The U.S. FWS wetland inventory maps (1980) also identified four wetlands associated with excavated areas such as gravel and borrow pits and irrigation canals that are classed as palustrine (Figure 3.7-2). These areas were examined in the field during the September reconnaissance. The excavated areas were denuded of vegetation and, because of their location and level of human activity and disturbance, provide limited wildlife habitat.

Five palustrine emergent wetlands in agricultural fields in the EMF study area that were identified by the U.S. FWS (1980) were devoid of vegetation at the time of the reconnaissance (September) or could not be located. It is likely that the wetlands that could not be located had been altered and farmed or were not evident because of the time of year. Because these wetlands and the surrounding area have been disturbed for agriculture, they do not provide important wildlife habitats.

The five wetlands identified on the wetland inventory maps (U.S. FWS, 1980) along irrigation canals were associated with seepage areas. Species observed included cattails (*Typha latifolia*), sedges, and grasses. These wetlands provide some wildlife habitat for loafing and resting, but they are not significant because of the limited areal extent (less than 0.1 acre/0.04 hectare [ha]) and the varying water regimes in the irrigation canals.

Five palustrine emergent wetlands were identified on the Fort Hall Indian Reservation in association with springs (U.S. FWS, 1980). These were not examined in the field but, on the basis of their location, would be expected to provide good wildlife habitat for food, cover, and nesting.

Agricultural Areas

Agricultural areas, including fallow and disturbed areas (Figure 3.7-2), make up 40 percent (7,203 acres/2,916 ha) of the area within a three-mile radius of the EMF facilities. The predominant crops are potatoes and wheat. The predominant animal species include killdeer, magpies, bluebirds, blackbirds, mice, coyote, foxes, badgers, and mule deer.

Numerous clumps of even-aged old and dying cottonwood trees (*Populus angustifolia*) were noted adjacent to several old farmhouses in the agricultural areas (Figure 3.7-2). Most of these trees (over 40 feet [12 m] tall) were dead or dying, especially where the farmhouses were dilapidated or in shambles. These clumps appear to be dying from old age or from purposeful girdling. Other tree species adjacent to the cottonwoods, such as plum and ornamental junipers, appeared healthy. While some regeneration was noted on the cottonwoods, their appearance was typical of senescent cottonwood trees.

Other

Residential, industrial, and commercial areas make up approximately 20 percent of the area within a three-mile radius of the EMF facilities (Figure 3.7-2).

EMF Facilities–Onsite Vegetation and Habitat Types

Historically, the area of the EMF facilities was sagebrush steppe. Because of the disturbance associated with the facilities, little of this vegetation/habitat type remains. Vegetation habitats are found in the southern part of the facilities (Figure 3.7-2).

Except for these areas and the bluffs to the south of the EMF facilities, the undeveloped areas on the sites have low potential as wildlife habitat due to the surface disturbance and continual activities onsite. Open disturbed areas in both facilities are weedy or mostly bare ground, providing limited cover for wildlife such as small rodents, quail, foxes, and rabbits. Plant species observed at the EMF facilities include Russian thistle and brome grass (*Bromus tectorum*), with occasional rabbitbrush.

Areas on the southern edge of the Simplot facility presently are sagebrush steppe. Species found in these wetlands include cattails, willows, sedges, smartweed, and mint. In addition, steep rugged cliffs in Sections 18 (T5S 34E), 23, and 24 (T6S R33E) provide habitat for nesting raptors and may be potential habitats for bats.

At the FMC facility, the IWW ditch conveys noncontact cooling water from the IWW basin to the Portneuf River. Vegetation growing along this ditch includes Russian olive, alder, and elm trees, and weedy herbaceous species such as Russian thistle, dandelion, stinging nettle, and wild lettuce (*Lactuca sp.*). The trees along the drainage ditch provide limited nesting and cover habitat for small birds.

However, because of the activity in the surrounding facility and because there is other more productive habitat nearby along the Portneuf River, this area does not provide important wildlife habitat. This is also true of other equivalent areas identified at the FMC and Simplot properties.

A small wetland area, approximately 0.02 acre (0.01 ha), is located at the entrance of the FMC plant, between the grassed welcome area next to the check-in station and railroad tracks. Cattails (*Typha latifolia*), willows (*Salix exigua*), annual sunflower, Russian thistle, and brome grass (*Bromus sp.*) were noted in this area. Given the size of this wetland, and its proximity to the railroad and entrance to the FMC facility, it is of limited wildlife value. The wetland probably serves as a small retention basin for runoff from the grassed welcome area, with runoff being impounded by the railroad tracks and entrance road.

Special Status Plant Species

According to the Idaho Conservation Data Center, Nongame and Endangered Wildlife Program, Idaho Department of Fish and Game, no rare, threatened, or endangered plant species are known to occur in the EMF study area (Stephens, 1992).

3.7.1.2 Sensitive Habitats and Wildlife

Sensitive habitats are defined as those that are critical habitats designated for threatened or endangered species, special habitats designated by state and federal agencies, and wetland and riparian habitats.

Critical and Special Habitats

No critical habitat for threatened or endangered species or special habitats designated by the state or by federal agencies occur within the EMF study area, including at the EMF facilities.

The American Falls Reservoir, part of the Minidoka Wildlife Refuge System, occurs approximately 8 river miles downstream of the EMF facilities. Extensive wetland and riparian areas occur around the perimeter of the American Falls Reservoir. The northern area of the American Falls Reservoir, including the mouths of the Portneuf and Snake rivers (Portneuf and

Fort Hall Bottoms), provides habitat for overwintering and nesting of a variety of migratory species including waterfowl, shorebirds, waterbirds, and special status species such as bald eagle and trumpeter swan. Use of habitats in the EMF study area by some species is influenced by the proximity of the habitats to the American Falls Reservoir.

Wetland and Riparian Habitats

Numerous wetland/riparian habitats associated with Michaud Creek, Portneuf River, and adjacent springs, borrow areas, and irrigation canals in the EMF study area are described in Section 3.7.1.1.

EMF Facilities–Onsite Sensitive Habitats

One wetland occurs within the EMF facilities area. This very small wetland on the FMC property provides limited value for wildlife because of its location, (next to a railroad bed and shale ore dumper), size, weedy species composition, and lack of structural cover. See Section 3.7.1.1 for further description of this wetland.

In an arid environment where water is a limiting factor, such as in the vicinity of the EMF facilities, open water is very attractive to a variety of wildlife, especially migratory waterfowl. Therefore, some discussion is warranted regarding open water as a habitat for sensitive waterfowl species.

The surface impoundments (e.g., Ponds 8S, 8E, 11E, 12S, 13S, 14S, 15S, and 16S) at the FMC facility sometimes attract waterfowl for loafing and resting in standing water. In cooperation with the Idaho Department of Fish and Game, FMC has installed propane-operated Sonar® guns around these ponds to discourage waterfowl from landing. These devices operate 24 hours a day. In addition to the sonar guns, FMC's full-time pond crew uses shotgun firing blanks or special rounds, when available from Idaho Fish and Game, and slingshots to keep waterfowl off the ponds. FMC's experience is that the combination of these techniques is almost 100 percent effective in deterring use of the ponds by migratory game waterfowl such as ducks and geese.

These migratory game species may land from time to time, but do not remain on the ponds for any length of time. The techniques described above are less effective with American avocets.

Standing water on the gypsum stacks on the Simplot facility potentially could attract waterfowl and other wildlife in the adjacent sagebrush steppe habitats. Waterfowl attraction to this area would be low and occasional due to sparse vegetative cover around the edges of the stacks, and the amount and distribution of standing water on the stacks. No records are available of any wildlife use of these areas (Wolleson, 1992).

The Simplot dewatering pit, equalization pond, settling pond, and holding pond could also attract waterfowl and other waterbirds, although this would probably be limited to occasional loafing. Approximately 30 Franklin gulls were observed loafing on the surge pond northeast of I-86 during field reconnaissance in September 1992. Use of these ponds, however, is probably not significant since little vegetation grows adjacent to the ponds that would provide cover and food, and higher quality habitats nearby along the Portneuf River would be preferable (Figure 3.7-2).

Sensitive Wildlife

Sensitive wildlife is defined as those species that are state or federally designated as threatened and endangered, candidates for listing, and species directly in the human food chain.

Appendix G contains a list of all known wildlife species, both special status and nonspecial status, occurring on the Fort Hall Reservation and in habitats in the EMF study area.

The major habitats in the study area support species common to sagebrush steppe and riparian areas in southeastern Idaho (Groves and Marks, 1985). Other sensitive species that utilize habitats along the American Falls Reservoir also move up the Portneuf River and use its wetland and riparian habitats and the adjacent agricultural areas. However, the populations of waterfowl and other species present are not expected to be as large as those reported for the American Falls Reservoir and Snake River.

Riparian/wetland habitats along the Portneuf River within the Fort Hall Indian Reservation and those associated with springs in the EMF study area make up the most important habitat types in the study area. These areas provide food sources, cover, and nesting habitat as well as movement corridors for sensitive species including waterfowl, white-tail deer, and mule deer. No data are available on population sizes or trends in the study area for waterfowl, nesting colonial waterbirds, or upland game birds and big game species (Anderson, 1992; Trost, 1992; Christopherson, 1992).

The occurrence and use of habitats by special status species in the EMF study area are discussed below by species and species group.

Bald Eagles. Bald eagles (*Haliaeetus leucocephalus*) utilize habitats on and around the American Falls Reservoir as either winter migrants or nesting residents. The overwintering eagles are made up of two populations, one that uses the reservoir and Snake River, and one that uses habitats south of the American Falls Dam. The nesting residents occur along the Snake River near McTucker Island in Bingham County (Howard, 1992a), approximately 17 miles (30 km) northwest of the EMF facilities.

Since 1980, the U.S. FWS, BLM, and Idaho Department of Fish and Game have conducted midwinter bald eagle surveys to estimate the size of overwintering populations. Over the last 12 years, populations at the American Falls Reservoir have ranged from a high of 57 in 1981 to a low in 1986 of four (BLM data files). In 1990, counts totaled 16; in 1991, counts totaled 26; and in 1992, counts totaled 17 bald eagles. In the 1990 survey of the entire reservoir, 10 bald eagles were counted in the northeastern part of the reservoir, and in 1991, 17 bald eagles were counted in the same area (Idaho Department of Fish and Game, 1990-1991). These numbers provide a general index of the population of bald eagles using the northeastern portion of the reservoir, including the Portneuf River floodplain.

In the northeastern portion of the American Falls Reservoir, bald eagles are most frequently observed along the Snake River drainage and mouth of the Snake River in open water where waterfowl congregate and at the mouths of Spring Creek, Clear Creek, Portneuf River, and Bannock Creek. Use in these areas varies depending upon open water and the aggregation of waterfowl in the area. Waterfowl concentrations vary yearly, depending upon areas of open water (Idaho Department of Fish and Game data files and Howard, 1992b).

Sightings of bald eagles in the northeastern portion of the American Falls Reservoir for 1992 were summarized by the Bureau of Reclamation on GIS maps for the American Falls Resource Management Plan (U.S. Department of the Interior, 1992). Concentrations of wintering bald eagles were mainly in the Snake River Drainage and open waters of the American Falls Reservoir. Three bald eagle sightings were recorded in the Portneuf River floodplain in Sections 26 and 27 (R33E, T5S) in 1992 by Bureau of Reclamation biological consultants.

No night roost locations are known along the Portneuf River or the Portneuf floodplains; however, the U.S. FWS and Idaho State University experts (Howard, 1992a; Trost, 1992) indicated that eagles occasionally use trees as day roosts along the Portneuf River up to I-86. Eagles are thought to take wounded waterfowl that move up the Portneuf River for cover during waterfowl hunting season in the winter. Bald eagles also take fish in the 7- to 20-inch (18- to 51-cm) size classes. Other prey sources include black-tailed jackrabbit (*Lepus californicus*) and deer and livestock carrion (Howard, 1992a). During the February 1993 reconnaissance, an immature bald eagle was observed hunting along the Portneuf River in Section 26 R33E T6S.

No known eagle nest has been identified in the Portneuf River floodplains area. The closest known eagle nest to the American Falls Reservoir is on the Snake River in Bingham County, over 6 miles (9.6 km) northeast of the Portneuf River mouth (Howard, 1992a).

Bald eagles may occasionally use the Portneuf River for hunting, but this would depend upon the overwintering bald eagle population size in the northeastern part of the American Falls Reservoir, waterfowl concentrations and distributions, weather, and open water on the American Falls Reservoir.

Peregrine Falcon. Peregrine falcons (*Falco peregrinus*) are known to migrate through the vicinity of the American Falls Reservoir (Trost, 1992; Cooper, 1992) and could be expected to occasionally use habitats in the EMF study area for hunting during migration. Peregrine falcons forage in areas of low vegetation, and their prey base includes waterfowl and passerine birds.

Other Raptors. Most of the raptor species listed in Appendix G are common in the open country of southeastern Idaho. Migratory raptors include peregrine falcon, Gyrfalcon (*Falco rusticolus*), ferruginous hawk (*Buteo regalis*), rough-legged hawk (*Buteo lagopus*), Cooper's hawk (*Accipter cooperii*), osprey (*Pandion haliaetus*), and northern harrier (*Circus cyaneus*).

The golden eagle (*Aquila chryaestos*) and prairie falcon (*Falco mexicanus*), historically have nested south of the EMF facilities in the bluffs (Howard, 1992a; Renn, 1992; Hogander, 1992). Historic golden eagle nest sites are in the NE 1/4 of Section 19 R34E, T6S. Prairie falcon eyries have been located in both the SE 1/4 of Section 19 R34E, T6S and SE 1/4 of Section 24 R33E, T6S. Both species' nests were successful in 1990, according to Renn (1992). During the spring reconnaissance in June 1993, the golden eagle nest site listed above was active. Two eaglets were observed in the nest, and an adult was observed soaring in the vicinity. No active prairie falcon eyries were noted. A kestrel nest was noted in a juniper snag in Section 19 R34E, T6S.

The following section describes the ecology of two representative raptors, the red-tailed hawk (*Buteo jamaicensis*) and the barn owl (*Tyto alba*), observed or expected near the EMF facilities.

The red-tailed hawk is a daytime avian predator of ground dwelling vertebrates, particularly rodents and other small mammals. They hunt primarily from an elevated perch, often near woodland edges (Bohm, 1978a; Janes, 1984; Preston, 1990).

Nesting sites in low density forests are found close to the tops of trees (Bednarz and Dinsmore, 1982), and when trees are scarce, nests are built on other structures, on rock pinnacles, ledges, or man-made structures (Brown and Amadon, 1968; MacLaren et al., 1988). The primary diet for this species consists of small mammals including mice, shrews, voles, rabbits, and squirrels. They also eat a wide variety of foods depending on availability, including birds, lizards, snakes, and large insects (Bent, 1937; Craighead and Craighead, 1956; Fitch et al., 1946). The red-tailed hawk is opportunistic and will feed on whatever species are most abundant (Brown and Amadon, 1968). The hawks egest pellets containing undigestible part of their prey, such as hair and feathers. The bones are usually completely digested.

Red-tailed hawks are found in habitats ranging from woodlands, wetlands, pastures, and prairies to deserts (Bohm, 1978b: Gates, 1972; MacLaren et al., 1988; Mader, 1978). The preferences are for a mixed landscape containing old fields, wetlands, and pastures for foraging, interspersed with groves of woodlands and bluffs and streamside trees for perching and nesting (Brown and Amadon, 1968; Preston, 1990). Moderately shallow (7.6 to 15.1 m height) cliffs along the river bank were the preferred habitat in a Snake River population (U.S. Department of the Interior, 1979). Riparian sections and the bluffs south of the EMF facilities ideally provide the most suitable habitat. Home range size can vary from a few hundred hectares to over 1500 hectares (3,706 acres).

Barn owls are primarily night hunters, although they will hunt during winter days. These behaviors correspond to the activity patterns of their primary prey, small mammals. Hunting typically occurs from perches that are one to three meters above the ground, and has been found to occur within a 530 ha (1,310 acres) area of the nesting site (Avery, 1992; Gubayni et al., 1992). Preferential small mammal habitat is provided by long strips of grassland bounded by edge areas of fence rows, ditches, hedges, and woodlands (Taylor 1994). The primary diet for the barn own consists of mice, moles, shrews, cotton rats, barn rats, gophers, ground squirrels, cottontails, and jackrabbits (Bent, 1938). Owls consume their prey whole, and egest the skeletal pellet. Smith and Richmond (1972) observed gastric pHs of approximately 2.0 to 5.0 in an adult barn owl immediately before feeding. The data suggest that the adult owl would not absorb significant concentrations of minerals associated with the prey's bone matrix.

Barn owl reproductive success is apparently directly related to small mammal availability and the amount of rainfall (which increases rodent populations; Colvin, 1984), and is inversely related to the extent of human disturbance and agricultural practices (Gubanyi et al., 1992). Taylor (1994) observed that egg production is positively related to the extent of surrounding suitable forage habitat. Barn owls spend their day roosting in old buildings, caves, hollows of trees, or thick foliage, such as pines or cedars (Terres, 1991). Roosting on the ground in agricultural fields has also been observed (Colvin 1984; Rosenburg 1986). In the EMF study area, the riparian and agrarian areas may provide more suitable habitat than the sagebrush-steepe areas because of the presence of a larger number of roosting sites, a smaller amount of prey cover, and a drinking water source (the Portneuf River).

No census data are available for raptor populations in the EMF study area. Idaho Fish and Game Department biologists indicate that the populations are at carrying capacity (Anderson, 1992; Cooper, 1992) given the type of habitats in the area and agricultural activities. During the winter reconnaissance along the Portneuf River, five species of raptors were observed hunting along the river, including the rough-legged hawk, marsh hawk, red-tailed hawk, great horned owl, and golden eagle. During the spring reconnaissance, marsh hawks, kestrels, and golden eagles were observed in the EMF study area.

Waterfowl. Numerous waterfowl species winter in the American Falls Reservoir area, and most of the species listed in Appendix G would be expected to occur in the wetlands and riparian habitats and open water along the Portneuf River. The U.S. Department of Interior Bureau of Reclamation maps (1992) show waterfowl nesting and brooding habitat as well as spring aggregation areas extending up along the Portneuf River and adjacent wetland riparian habitats to Section 36 R34E, T6S. The agricultural fields adjacent to the river also provide food for numerous species including Canada geese (*Branta canadensis*), goldeneye (*Bucephala clangula*), and ruddy ducks (*Oxyura jamaicensis*) (Trost, 1992).

Population sizes of waterfowl in the wetlands and riparian habitats along the Portneuf River are not available. Summaries are available of Idaho Department of Fish and Game surveys as part of the U.S. FWS winter waterfowl surveys for Region 5 (American Falls Reservoir, Snake River to Massacre Rocks up to Blackfoot River and Fort Hall Bottoms). The winter survey counts for winter waterfowl (mallards, *Anas platyrhynchos*; gadwell, *Anas strepera*; wigeon *Anas americana*, green- and blue-winged teal, *Anas crecca* and *A. discors*; pintail; redhead, *Aytha americana*; goldeneyes; buffleheads, *Bucelphala albeola*; ruddy ducks; mergansers, *Mergus merganser*; Canada geese; snow geese, *Chen caerulescens*; swans, *Cygnus sp.*) are summarized in Table 3.7-2.

Duck and goose harvest data for the Fort Hall Bottoms of the Fort Hall Indian Reservation area (Shoshone-Bannock Tribe, 1992) are summarized in Table 3.7-3. Mallards are considered to be the most important of waterfowl species for hunting on the Fort Hall Indian Reservation (Christopherson, 1992).

The above-mentioned overwintering surveys covered a larger habitat area than that along the Portneuf River in the EMF study area. These estimates, however, provide a general index of fluctuations in population sizes and species in the area, which proportionally would be reflected in concentrations and occurrences along the Portneuf River and adjacent wetland and riparian habitats similar to those surveyed along the American Falls Reservoir. During winter reconnaissance along the Portneuf River, waterfowl groups dominated by mallards occurred in sizes up to 200 individuals. Other less numerous species observed in shallow, sheltered areas along the river include widgeon, goldeneye, redhead, teal, and Canada geese. During spring reconnaissance, up to 20 mallard pairs were flushed along the river from Batiste Springs Road to the mouth of the Portneuf River.

Colonial Nesting Waterbirds. Colonial nesting waterbirds are addressed in this characterization since they are at the top of the aquatic food chain, and use aquatic and riparian habitats along the Portneuf River. Three species of colonial nesting waterbirds — great blue herons (*Aredea herodias*), black-crowned night herons (*Nycticorax nycticorax*) and white pelicans (*Pelecanus erthrorhynchos*) — occur in the EMF study area along the Portneuf River. During spring reconnaissance, no nest sites were observed along the Portneuf River from Pocatello to the mouth of the Portneuf River.

Black-crowned night herons have been reported feeding at the fish farm at Batiste Springs (Henny and Burke, 1990; Trost, 1992). These birds are not considered year-long residents but migrate to Mexico (Trost, 1992).

The closest heron rookery (not active) documented during field reconnaissance was noted approximately 8 miles (13 km) downriver in Section 22 R33E T5S at the mouth of the Portneuf River. Approximately 10 nests were observed during the October 26-30, 1992, sediment sampling. Because of high waters and inclement weather in the spring, this area could not be examined for activity.

White pelicans also hunt along the Portneuf River on the Fort Hall Indian Reservation, taking suckers and carp (Christopherson, 1992). Maps for the U.S. Department of Interior Bureau of Reclamation (1992) of pelican use areas show that two concentration areas occur in the northwestern part of the American Falls Reservoir[about 15 miles (24 km) from the EMF site] and a smaller use area occurs between the Portneuf River mouth and 2 miles (3.2 km) north of Bronco Point along the reservoir. During spring reconnaissance, four white pelicans were observed on the river near river mile 10, and up to 50 were seen at the mouth of the Portneuf.

Upland Game Birds and Big Game. Numerous upland game birds and big game occur in the EMF study area. Appendix G lists the species and habitats in which they occur. No data are available from the Idaho Department of Fish and Game or Bureau of Land Management regarding harvest data or populations of upland game birds, mule deer, and white-tail deer in the EMF study area. Pheasant harvest data on the Fort Hall Indian Reservation in agricultural and wetland habitats show harvests of 675 in 1988, 1,090 in 1989, and 1,084 in 1990 (Shoshone-

Bannock Tribe, 1992). Two chukar were observed in the EMF facilities area and on the face of the gypsum stack during spring reconnaissance.

Sage grouse occur in the sagebrush steppe habitats in the study area. However, no data are available on populations (Anderson, 1992; Christopherson, 1992).

While no harvest data are available for mule deer and white-tail deer (*Odocoileus virginianus*) in the EMF study area, both species are considered important hunting resources on the Fort Hall Indian Reservation.

Mule deer frequently inhabit semiarid, open forest, brush, and shrub lands and are especially abundant in mountain-foothill regions. Population densities in the EMF study area would be similar to a mix of open and broken prairie ($\leq$0.5 to 4.5 deer/km^2) (Mackie et al., 1982). Mule deer concentrate in areas of substantial topographic and vegetative diversity, including breaks along river drainages, heavily dissected badlands, and brushy stream courses (Hamilton 1978a,b). Foothills and mountains often sustain dense populations (4-7 to 16 deer/km^2).

The mule deer is a herbivore. It feeds on a wide variety of plant species, including trees and shrubs, forbs, grasses, sedges, and rushes (Mackie et al., 1982). Generalizing the mule deer's diet is extremely difficult due to its dynamic nature; however, a dietary study of mule deer in western Wyoming can serve as a rough approximation. This study found a seasonal rotation in diet. Key winter browse species included big sagebrush, bitterbrush, juniper, and snowbrush (Ingles, 1965; Thomas, 1991; Wallmo, 1981; Welch, 1983). In the spring and summer, the leaves of woody plants remain the primary food source with forbs and grasses, such as alpha and bunch grass increasing in importance (Taylor, 1956). During the late summer and early fall, berries and other fleshy fruit, such as bitterbrush, chokecherry, and serviceberry, become an important food source (Holte, personal communication). Mule deer are well adapted for arid environments and cope well with a scarcity of water.

In the EMF study area, mule deer habitat occupancy may be seasonally determined. During the transitional climate of spring, mule deer are expected to primarily feed on bunch grasses and fibrous plants characteristic of sagebrush steppe. Bitterbrush and juniper may provide primary nutrition sources. After a brief early summer stay at higher elevations, mule deer may graze on the more succulent vegetation of the riparian section. During mild winters, the sagebrush steppe habitat south of the facility should again represent the preferred habitat. However, migration from this area would be expected during periods of heavy snow accumulation. Therefore, depending on climatic conditions, winter range of the mule deer can vary from the sagebrush-grass vegetation type upward into the mountain brush cover type. In semidesert range, home ranges for males and females were found to be 12.4 km^2 and 10.6 km^2, respectively (Rogers et al., 1978). Therefore, under most (non-migratory) conditions, the home range of mule deer is sufficiently large that exposure to EMF-related impacted areas would be minimal.

Bats. Potential habitat of a Federal Category 2 species, the Townsend's big eared bat (*Plecotus townsendii*) occurs immediately south of the EMF facilities in the bluffs. This species, which is being proposed for listing as a threatened or endangered species, has been observed in habitats within 6.2 miles (10 km) of the bluffs in similar habitats (Wackenhut, 1992). No records occur on the Idaho Conservation Data List. Dr. Barry Keller, Curator of Mammals, Idaho Museum of Natural History, has also indicated a high probability of occurrence of this species based upon habitat (Keller, 1992). No bat activity was noted during spring reconnaissance in the cliffs on or south of the EMF facilities. In addition, no sightings of bat activity were reported by the U.S. FWS, BLM, or the Idaho Department of Fish and Game.

Other Mammals

A variety of mammals common to sagebrush steppe and agrarian habitat are found near the EMF facilities. For example, the red fox (*Vulpes vulpes*), is a representative mammalian predator, primarily existing in or near open agrarian fields. Foxes prey mainly upon small mammals, but also feed upon birds, insects, and fruit (Korschgen, 1959; Samuel and Nelson, 1982). In addition to hunting, foxes scavenge carcasses (Voigt, 1987) and feed on plant material, primarily fruits, berries and nuts when available. Green and Flinders (1981) found rodents, especially cricetid mice, to be the prevalent food item in all seasons in southeastern Idaho.

The basic social unit of foxes is the family, which generally consists of a mated pair or a male and several related females (Voigt, 1987; MacDonald, 1980). Additional females are usually nonbreeding and often help the breeding female (Voigt, 1987).

Home ranges of foxes from the same family often overlap to a considerable degree, creating a larger family territory (Sargeant, 1972; Voigt and MacDonald, 1985). Family territories are largely contiguous and nonoverlapping resulting in a landscape which is almost entirely utilized by foxes (EPA, 1993). While territory sizes range from 50 to 3,000 ha (124 to 7,413 acres), one family's territory is typically 100 to 1,000 ha (247 to 2,470 acres) in size (EPA, 1993). Red foxes are readily adaptable and live in numerous habitats: cropland, rolling farmland, brush, pastures, hardwood stands, and coniferous forests (MacGregor, 1942; Eadie, 1943; Cook and Hamilton, 1944; Ables, 1974). Broken and diverse habitats, such as agricultural regions, are particularly preferred (Ables, 1974; Samuel and Nelson, 1982; Voigt, 1987). In Idaho, red foxes were documented to be inhabiting new terrains previously unoccupied by the species, including cultivated areas, cool deserts of the foothills, and the Snake River Plain (Aubry, 1984).

3.7.2 AQUATIC ECOSYSTEMS

Aquatic habitat in the Portneuf River is generally shallow riffles with cobble and gravel substrate in the immediate area of the EMF facilities, changing gradually into deeper habitat with slower currents and more mud/silt substrates near Siphon Road. The low stream banks typically support temporarily flooded shrub communities. Springs and groundwater hydrology are major influences on the aquatic habitat near the EMF facilities and downstream. Groundwater and springs significantly increase the river flow and tend to be warmer in winter and cooler in summer than the upstream river water. This provides a more stable aquatic habitat by limiting temperature extremes in the river. Luxuriant growths of macrophytes occur in the sections of the river influenced by the numerous springs.

Water quality is reduced by numerous point and nonpoint sources both above and below the FMC outfall.

No endangered or threatened species and no critical habitats were identified in the EMF study area. Important aquatic species in the area include game fish and sucker (which are eaten by people), and mottled sculpin, which is probably the second most common fish in the Portneuf River and a significant food source for many of the higher vertebrates. Macroinvertebrates are also a major food source for fish, birds and amphibians, and are important in determining the well-being of those populations.

Two fish farms on the Portneuf River below the EMF facilities raise coho salmon and rainbow trout for stocking other streams and for human consumption.

3.7.2.1 Aquatic Habitats

The only significant aquatic habitat in the EMF study area is the Portneuf River. The hydrology and water quality of the Portneuf River are described in Sections 3.2 and 4.5, respectively. Surrounding land uses and water uses, according to the City of Pocatello (1989), have had a marked effect on the quality of the aquatic habitat in the Portneuf River. Public health warnings were issued during the study period regarding avoidance of contact sports in the river due to bacterial contamination resulting from untreated sewage discharges (Low, 1993). Water quality improves markedly with the introduction of groundwater underflow and springs below I-86.

From I-86 downstream to the diversion dam near Siphon Road, the deepest portion of the Portneuf channel (the thalweg) changes from shallow riffle habitat with predominately cobble and gravel substrate habitat to deeper habitat with slower currents and mud/silt substrate habitat, as observed during field reconnaissance. The channel margins reflect depositional characteristics of the natural flow regime (i.e., point bars and chute bars). Further information on river morphology is provided in Section 3.2.1. The amount of mud and silt in this portion of the river may also change with seasonal flow. The diversion dam at Siphon Road is removed each year before high water flow. Below this diversion dam, bottom materials are again predominantly cobble and gravels down to the Fort Hall Bottoms.

Hydrology

The hydrology of the Portneuf River is described in detail in Section 3.2 and only the information relevant to characterizing the aquatic habitat is summarized here.

The annual hydrograph of the Portneuf River (Figure 3.7-3) is generally dominated by spring high water runoff from the melting of mountain snowpacks. Flows are at minimum levels during the summer months. RI data confirm this flow pattern.

The Portneuf River becomes a gaining stream north of I-86, and is recharged by underflow from groundwater. In the EMF study area, numerous springs enter the river downstream (north) of I-86. (Flow quantities from these springs and other sources of the Portneuf River are described in Section 3.2.) The Pocatello STP also discharges into the Portneuf River about 0.8 mile (1.3 km) below the EMF facilities, and 0.6 (1.0 km) mile downstream from I-86.

In addition to spring tributaries that have identifiable confluences with the Portneuf River, other areas of groundwater discharge within the river channel are visibly apparent as indicated by patterns of water clarity, temperature, and the distribution of aquatic macrophytes (Brock, 1989). The surface and groundwater hydrology of this reach of the Portneuf River is very complex and is a major influence on the aquatic habitat.

In the EMF study area, the Portneuf River ecosystem has two annual critical periods related to flow and pollution. The first is the high-flow or runoff season, which may create the following stresses on the river ecosystem:

- High-velocity water flows wash away food for aquatic organisms.
- Habitats are disrupted by the high flows (800 cfs [22 cms] or more).

- High levels of suspended sediments are washed into streams, covering up needed food and blocking the amount of sunlight that reaches the oxygen producers such as algae and macrophytes (rooted aquatic plants).
- Toxic materials can be washed into a stream at this time. (Note that runoff is controlled at the EMF facilities and does not enter the river.)
- There can be significant morphological changes as stream banks are cut and sloughed and meanders are altered.

The second critical period is during the summer when flow is low and stresses may be created by the following (McSorley, 1976):

- High temperatures, which reduce dissolved oxygen (DO) concentrations.
- Greater impacts of City of Pocatello wastewater discharge. (The City of Pocatello has minimized this impact since 1980 by diverting treated effluent to irrigation.)
- Tendency to concentrate toxic materials and nutrients in water.
- Reduced habitat (decreased areal extent of river) for macroinvertebrates and fish.

Table 3.7-4 shows the width, depth, and flow characteristics at selected locations on the Portneuf River observed in the field on October 27, 1992. River flow increases significantly below Batiste Road (and I-86) due to the groundwater underflow and spring discharges. Based upon field reconnaissance of the river in 1992, aquatic plants (both rooted and floating) appeared to be much more abundant below I-86 in comparison to the stretches upstream of the EMF facilities.

Land Use and Vegetation

The predominant land use along the river is undeveloped with native riparian vegetation. A few areas near Pocatello are disturbed by construction or industrial activities; most other disturbances are due to agricultural activities, particularly livestock, and breakdown on river banks (Section 3.6.2, Land Use, and Figure 3.7-2).

Stream banks along the Portneuf River typically support temporarily flooded shrub communities. Peachleaf willow and alder are the common overstory species while sedges, grasses, and forbs tend to dominate the herbaceous layer. Dense thickets of coyote willow are common in the intermediate shrub layer. The peachleaf willow and alder overstory commonly reach heights of 27 to 36 feet (8 to 11 m); the intermediate shrubs (e.g., coyote willow, rose, currant, and red osier dogwood) typically reach 5 to 10 feet (1.5 to 3 m) in height. The herbaceous layer typically include basin wildrye, brome, timothy, festucea, spiny hopsage, and thistle. The river canopy is mostly open, with scattered groups of peachleaf willow and alder covering the river. The shrub and grass layers tend to be thick and overhang the banks. The riparian/wetlands along the river are also discussed in Section 3.7.1.2.

Water Quality

The quality of the groundwater and surface water is discussed in detail in Section 4 of this report. The information presented here emphasizes the ecological aspects. Water quality is one of the primary considerations in determining habitat quality for aquatic organisms.

Pollution sources such as the Pocatello STP, uncontrolled raw sewage discharges containing E. coli bacteria, and storm water runoff from the urbanized areas affect the water quality of the Portneuf River. Other important pollutants entering the Portneuf River include suspended solids from tilled croplands, organic wastes from cattle, nitrogen and phosphorus compounds from fields, and animal wastes (Minshall and Andrews, 1973). FMC currently discharges noncontact cooling water to the Portneuf River under an NPDES Permit. Until 1980, Simplot also discharged effluent from its water treatment ponds to the river. The nutrient-rich effluent is now collected and sold for irrigation and fertilization.

Pocatello's STP discharges to the river from the east bank, about 0.9 mile (1.5 km) downstream (north) from FMC's IWW ditch outfall. According to the City of Pocatello (1989), the STP effluent has an organic content typical of well-operated secondary treatment facilities (5-day, biological oxygen demand, and total suspended solids are each typically lower than 20 mg/l). Ammonia is a normal degradation product of proteins. Figure 3.7-4 illustrates the variability during the 1988-89 study period in ammonia-nitrogen content of the plant's effluent (City of Pocatello, 1989).

As reported by the City of Pocatello (1989), factors that are relevant to mixing characteristics of the STP effluent are the nature of the discharge (a straight pipe on the east bank of the river), and the presence of a medial bed of macrophytes that virtually divides the channel in two for the first 330 to 660 feet (100 to 200 m) downstream from the discharge point. The medial macrophyte bed and the discharge of a portion of Batiste Spring nearly opposite the effluent pipe combine to provide a zone along the west bank of the river which, according to the City of Pocatello, appeared to have been minimally impacted by the STP effluent (City of Pocatello, 1989).

Groundwater underflow and discharge from Batiste and Swanson Road springs also have an important impact on the water quality of the Portneuf River. Groundwater and springs tend to be warmer in winter and cooler in summer than water reaching the area from upriver. Like many rivers that attain their maximum water temperature during minimum flow periods of summer, the lower Portneuf is warmest when the river flow is lowest. As indicated by the City of Pocatello (1989), the moderate temperatures found in the gaining reach influence ecological processes in several ways, including lowering of respiration rates, reducing the fraction of ammonia that is in an un-ionized (toxic) form, and increasing the solubility of dissolved gases, such as oxygen.

The DO concentration at a sample point in a river for a given time is a function of numerous factors operating upstream including: physical influences (temperature, pressure, gas solubility, and channel characteristics that affect reaeration); and the biomass and rates of activity of organisms that release and consume DO through life processes such as photosynthesis and respiration. Data reported by the City of Pocatello (1989) from the Portneuf River at the Rowland creamery follow a typical pattern of increasing DO during the day, associated with photosynthesis, and decreasing DO at night, due to respiratory processes (Figure 3.7-5). Diel swings (cyclic increases and decreases over the day) in DO at the Rowland creamery were more pronounced during the fall of 1988 than in the summer of 1989. The City of Pocatello maintains this is probably due to greater accumulation of plant biomass in the river channel later in the growing season. (The influx of groundwater and spring water to the Portneuf downstream from

Batiste Road is accompanied by substantial macrophyte beds that typically cover half the channel.)

Downstream from the STP discharge, the minimum daily DO at dawn as measured by the City of Pocatello (1989) was in excess of 5.5 mg/l (60-percent saturation), even in midsummer. Such DO levels are considered adequate to maintain a salmonid fishery. In this study, DO levels tended to be slightly lower (about 0.5 mg/l) at the fish farm site than at the Rowland creamery. The City of Pocatello concluded that this would be expected, due to in-stream conversion of ammonia to nitrite and nitrate (nitrification), a chemoautotrophic process that requires oxygen. There was no evidence of toxic oxygen conditions associated with Pocatello's STP effluent in the study reach, even under conditions that would be potentially most stressful (i.e., maximum summer temperatures with minimal dilution of treatment plant effluent) (City of Pocatello, 1989).

According to the Idaho Department of Health and Welfare, Division of Environmental Quality (1989), storm drain discharges from the City of Pocatello are a potential major source of contaminants to the river. Chemical analyses of drain water indicated levels of suspended solids, total solids, chemical oxygen demand, sodium, potassium, chloride, fluoride, arsenic, cadmium, hexavalent chromium, copper, iron, lead, manganese, and zinc higher than any of the three major NPDES discharges to the Portneuf River.

The occurrence of a thunderstorm while continuous monitoring equipment was operational near the Rowland creamery (upstream of the STP discharge) revealed potential DO problems associated with storm runoff from the watershed. A localized storm of undocumented intensity (no rain was recorded at the Pocatello Municipal Airport weather station) on August 10, 1989, was followed by DO concentrations that fell to 3.5 mg/l during the early morning hours of August 11, and remained below the acute lethal threshold of 4.0 mg/l (EPA, 1989f) for 2 to 3 hours (Figure 3.7-5). The City of Pocatello (1989) postulated that these low oxygen levels were associated with chemical oxygen demand associated with organics washed into the channel by storm runoff as well as with organic deposits stirred up by the elevated flow of the river.

3.7.2.2 Sensitive Aquatic Species and Habitats

Sensitive aquatic species include the following categories:

- Endangered Species — Any species in danger of extinction throughout all or a significant portion of its Idaho range.
- Threatened Species — Any species likely to be classified as endangered within the foreseeable future throughout all or a significant portion of its Idaho range.

On the basis of discussions with the Natural Heritage Section of the Idaho Department of Fish and Game, and a review of the 1992 list of rare, threatened, and endangered plants and animals of Idaho (Moseley and Groves, 1992), it was determined that no endangered or threatened species occur in the Portneuf River in the EMF study area.

Sensitive habitats evaluated in this site characterization are classified as those that are critical habitat designated for threatened or endangered species, special habitats designated by state and federal agencies, and wetlands. No critical habitat for threatened or endangered species, or special habitats designated by state and federal agencies, occur in the EMF study area.

3.7.2.3 Important Aquatic Species and Habitats

These species include those fish used for human consumption and as food for other fish and macroinvertebrates. Also discussed are fish farms on the Portneuf River.

Aquatic Species Targeted for Human Consumption

Aquatic species that are targeted for human consumption are primarily game fish, which are identified in Table 3.7-5. These fish include trout (hatchery and wild rainbow, brown, and hybrid trout); kokanee salmon that have escaped from commercial fish farms; mountain whitefish, yellow perch, black crappie, and catfish (black bullhead, brown bullhead, and channel catfish).

Sucker are also eaten sometimes (Sigler and Sigler, 1987). The more important fish in the Portneuf River in the EMF study area are discussed in the following subsections.

In studies reported by the City of Pocatello (1989), fish populations were estimated for four study sections of the Portneuf River immediately above and below the STP. These data were summed for the four study sections and are presented in Figure 3.7-6. It should be noted that this field study was hampered by large quantities of floating vegetation.

These data show larger populations of nongame fish than game fish and more total fish present in the fall of 1988 than in the summer of 1989. In this study, game fish consisted of brown trout, rainbow trout, and rainbow-cutthroat trout hybrids. Nongame fish included whitefish, carp, sculpin, shiner, and dace. Many of the trout captured in this study were from the fish farm at Batiste Spring. Sculpin and dace, which are considered indicators of high-quality water, were scarce below the STP, due in part to changes in water quality or habitat. However, they were still among the most common fish reported in the Portneuf River (Figure 3.7-7).

Rainbow Trout. Rainbow trout *(Oncorhynchus mykiss)* including hatchery, wild, and hybrids, are one of the most common game fish in the Portneuf River (Figure 3.7-6) and one of the most important game fish in the Great Basin (Sigler and Sigler, 1987). The Idaho Department of Fish and Game stocked the Portneuf River with 500 to 1,000 catchable size rainbow trout (about 10 inches [25/4 cm] long) for the first time in 1992, but it has no formal management program because of poor access and low fishing pressure. These fish were part of an experimental program to measure catch success (Mende, 1992). Rainbow trout in this portion of the Portneuf River are nonmigratory.

The rainbow is the easiest and most economical of all trout to raise and is raised commercially at the Papoose Spring and Batiste Spring fish farms (Figure 3.7-2). Adult nonmigratory rainbow trout average 2.0 to 4.0 pounds (0.9 to 1.8 kg) and are considered large at 5.9 to 7.9 pounds (2.7 to 3.6 kg). The life span of rainbow trout is fairly short, with few living beyond 5 years of age.

Rainbow trout generally spawn on stream gravel bars in the spring when water temperatures reach 50°F (10°C) or more. The female digs a redd in the gravel, and eggs and sperm are deposited in the depression. Rainbow and cutthroat trout that spawn in the same area often hybridize (Sigler and Sigler, 1987).

Young rainbow trout feed on small benthic invertebrates, primarily insects and crustaceans. Rainbow trout more than any other trout tend to feed on algae and, to a lesser extent, on vascular plants. The amount of nourishment received from plants and algae may be slight, however. The rainbow continues the primarily invertebrate diet until reaching a size of 1.1 to 2.0 pounds (0.5 to 0.9 kg), then it tends to turn to a fish diet when it is available. Rainbow trout are primarily drift feeders, but will rise the surface and feed on surface insects. Where forage fish such as the Utah chub are available, the larger rainbow trout will eat them (Sigler and Sigler, 1987).

Brown Trout. Brown trout (*Salmo trutta*) are present in the Portneuf River but not in large numbers (Figure 3.7-7). It is more aggressive than most trout and readily feeds on other fish. This trout is native to Europe and western Asia and was first introduced into North America in 1883. By 1910 it was regularly stocked in western streams, and is now present in most trout waters throughout the United States and Canada (Sigler and Sigler, 1987). However, the Portneuf River is not stocked with brown trout by the Idaho Fish and Game Department (Mende, 1992). Brown trout spawn in the riffle areas from late October to December.

Brown trout usually average 3.9 to 6.6 pounds (1.8 to 3 kg) by their sixth year, and fish weighing 7.9 to 11.9 pounds (3.6 to 5.4 kg) are not uncommon. They may live 10 years or longer. In both lakes and streams, juvenile brown trout feed heavily on zooplankton and bottom-dwelling insects. A typical stream feeding pattern for brown trout as it grows older is from drift organisms and zooplankton, to aquatic and terrestrial insects, to small fish, and finally to large fish. The change to feeding on forage fish occurs at an earlier age in brown trout than most trout. Brown trout less than 2.0 pounds (0.9 kg) live largely on such insects such as mayflies, caddisflies, stoneflies, and midge larvae and pupae. Other foods include earthworms, freshwater clams, crayfish, salamanders, frogs, and rodents (Sigler and Sigler, 1987).

Besides being caught by fishermen, brown trout are preyed upon by fish-eating birds, mammals, and other fish (Sigler and Sigler, 1987). The brown trout is listed as intermediate in tolerance to environmental stress by the EPA (1989f).

Other Game Fish. Other game fish known to occur in Portneuf River include yellow perch, black crappie, black bullhead, brown bullhead, and channel catfish (Table 3.7-5). These fish are all primarily associated with lakes and reservoirs, and probably enter the Portneuf River from the American Falls Reservoir at various times of the year. There are no known population estimates for these species.

Coho salmon have been raised at the fish hatcheries on the Portneuf River and could be present as escapees from the hatcheries. Coho probably do not reproduce in the river, however, and would be limited to the life span of the escapees (Mende, 1992). None were found in the 1988 and 1989 studies of the fish populations in the Portneuf River by Broderick et al. (1989).

Other Important Aquatic Species

Other important aquatic species, discussed below, include suckers, mottled sculpin, and various macroinvertebrates.

Suckers. Both the Utah sucker (*Catostomus ardens)* and largescale sucker (*Catostomus macrocheilus)* are found in the Portneuf River. Suckers are probably the most common fish in the Portneuf River, both in terms of numbers and biomass (Figure 3.7-7). The median size of these fish is about 10 inches (25 cm) with weights ranging from 2.0 to 3.1 pounds (0.9 to 1.4 kg). These fish are relatively fast-growing and live about 10 to 12 years. They are currently not considered a game fish. It is used today for human consumption, although to a far lesser extent than in the past. However, approximately 329,000 pounds (149,400 kg) of sucker were taken commercially in the last half of 1992 from the American Falls Reservoir for human consumption

(Table 3.7-6). In addition to humans, suckers are also eaten by most piscivorous predators such as larger fish, mergansers, ospreys, and eagles (Sigler and Sigler, 1987).

Suckers feed on both plants and animals. As fry, suckers eat small zooplankton and as they grow larger and become bottom dwellers, they change their diets to aquatic insect larvae, diatoms, and other plant material. Large suckers feed on such bottom organisms as crustaceans, aquatic insect larvae, earthworms, and snails (Sigler and Sigler, 1987). The largescale sucker is listed as tolerant to environmental stress by the EPA (1989f).

Mottled Sculpin. The mottled sculpin (*Cottus bairdi*) is important because it is probably the second most common fish in the Portneuf River (Figure 3.7-6) and provides a significant amount of food for trout and other game fish. This fish attains an age of 5 years and occasionally a total length of 6.0 inches (15.2 cm). Lengths of 3.0 to 4.0 inches (7.6 to 10.2 cm) are more common, however. The mottled sculpin eats almost entirely aquatic insects, with plant material and fish a minor part of the diet (Sigler and Sigler, 1987).

The preferred habitat of the mottled sculpin is clear, cool mountain streams of rapid to moderate current. The bottom typically consists of coarse gravel, small loose rocks, or rubble. Preferred summer temperatures vary from 55.4°F to 64.4°F (12.8°C to 18°C) and water depths are commonly 1.9 ft (0.6 m) or less. These fish associate with vegetation and live under stones or in moderately swift riffles (Sigler and Sigler, 1987). The Portneuf River seems to provide good habitat for the mottled sculpin. The mottled sculpin is listed as intermediate in tolerance for environmental stresses (EPA, 1989f).

Macroinvertebrates. By convention, freshwater macroinvertebrates are those animals without backbones that are large enough to be seen without magnification. The main taxonomic groups of macroinvertebrates occupying freshwater environments are annelids, crustaceans, flatworms, mollusks, and insects (usually predominant) (Platts et al., 1983).

Macroinvertebrates are important intermediaries in the utilization of plant material, such as algae, vascular hydrophytes, leaves, and wood, and the recycling of nutrients in aquatic environments. They are a major food source for fish and serve to determine the well-being of those populations. The macroinvertebrates possess several characteristics that make them useful for detecting environmental perturbations: in particular, (1) most members of this community possess limited mobility so that their status reflects conditions in the immediate vicinity of the collection site, and (2) most of the organisms (mussels are the main exception) have life spans of several months to a few years. Thus, their characteristics are a function of conditions during the relatively recent past, including sporadic influences that would be difficult to detect by periodic microbial or chemical analysis (Platts et al., 1983).

Many of the important vertebrate species discussed in previous sections depend directly or indirectly on the macroinvertebrate organisms living in the benthos (river bottom) of the Portneuf River. Macroinvertebrates are eaten by a large variety of fish, birds, amphibians, and other organisms, which are themselves eaten by the top-level consumers such as eagles, cormorants, and herons.

The most recent study of the macroinvertebrate community in the Portneuf River was conducted by the City of Pocatello (1989) to determine the effects of its STP. Results from taxonomic analysis of the benthic samples suggest that there is environmental stress associated with the effluent discharged from the STP. Species richness is the number of different types or taxa of macroinvertebrates found at a site. During August 1989, the average species richness decreased from 12 taxa above the effluent pipe (but below the EMF facilities) to eight taxa at two stations located within the STP effluent plume. The organisms that tended to avoid Pocatello's STP effluent were those groups that are associated with clean flowing water and are especially sensitive to environmental stress (Ephemeroptera [mayflies], Plecoptera [stoneflies], and Tricoptera [caddisflies]).

Figure 3.7-8 shows the abundance of selected macroinvertebrate taxa at the five sample locations in relation to the approximate location of the STP effluent plume. Benthic scientists have ranked macroinvertebrate groups based on their tolerance of environmental stress. The scale of tolerance values (TV) ranges from 1 to 10, with 1 being the most susceptible to stress, and 10 the most tolerant. The Chironomidae and Oligochaeta are wormlike animals with aquatic forms that can survive in polluted environments; these groups have TVs in the 6 to 10 range. Groups with low tolerance to environmental stress–the Baetidae, the Tricorythidae (mayflies) and the Brachycentridae and Hydropsychidae (caddisflies)–were clearly less abundant in the effluent plume during summer 1989. Thus, in this 1989 study, the invertebrate groups with the lowest tolerance to environmental stress were most abundant in the area upstream from the STP discharge. The Oligochaeta, on the other hand, were relatively more abundant in the STP effluent than upstream from the effluent (City of Pocatello, 1989).

The general conclusion of the macroinvertebrate portion of the study was that there was a predominance of toxic-tolerant organisms, and a reduction in species richness downstream from the STP effluent. Since the macroinvertebrate sample location that was farthest downstream (Station 5) had the highest species richness and greatest abundance of mayflies, the study concluded that the west (spring water) side of the Portneuf River had comparatively good environmental health. This conclusion is consistent with the water chemistry results, which indicated the presence of a channel of high-quality water around the effluent mixing zone (City of Pocatello, 1989). The City of Pocatello concluded that this west side of the Portneuf River, which contains the outfall from the FMC facility, supported comparatively good aquatic habitat in comparison to reaches above the EMF facilities.

Fish Farms

Two fish rearing facilities are located on the Portneuf River in the EMF study area, at about river miles 12.4 (Batiste Spring fish farm at the Rowland creamery) and 11.4 (Papoose Spring) (Figure 3.7-2). Both of these properties are operated by Aqua Sea Inc. At the fish farm, coho salmon and rainbow trout are raised and sold for stocking other streams and processed elsewhere.

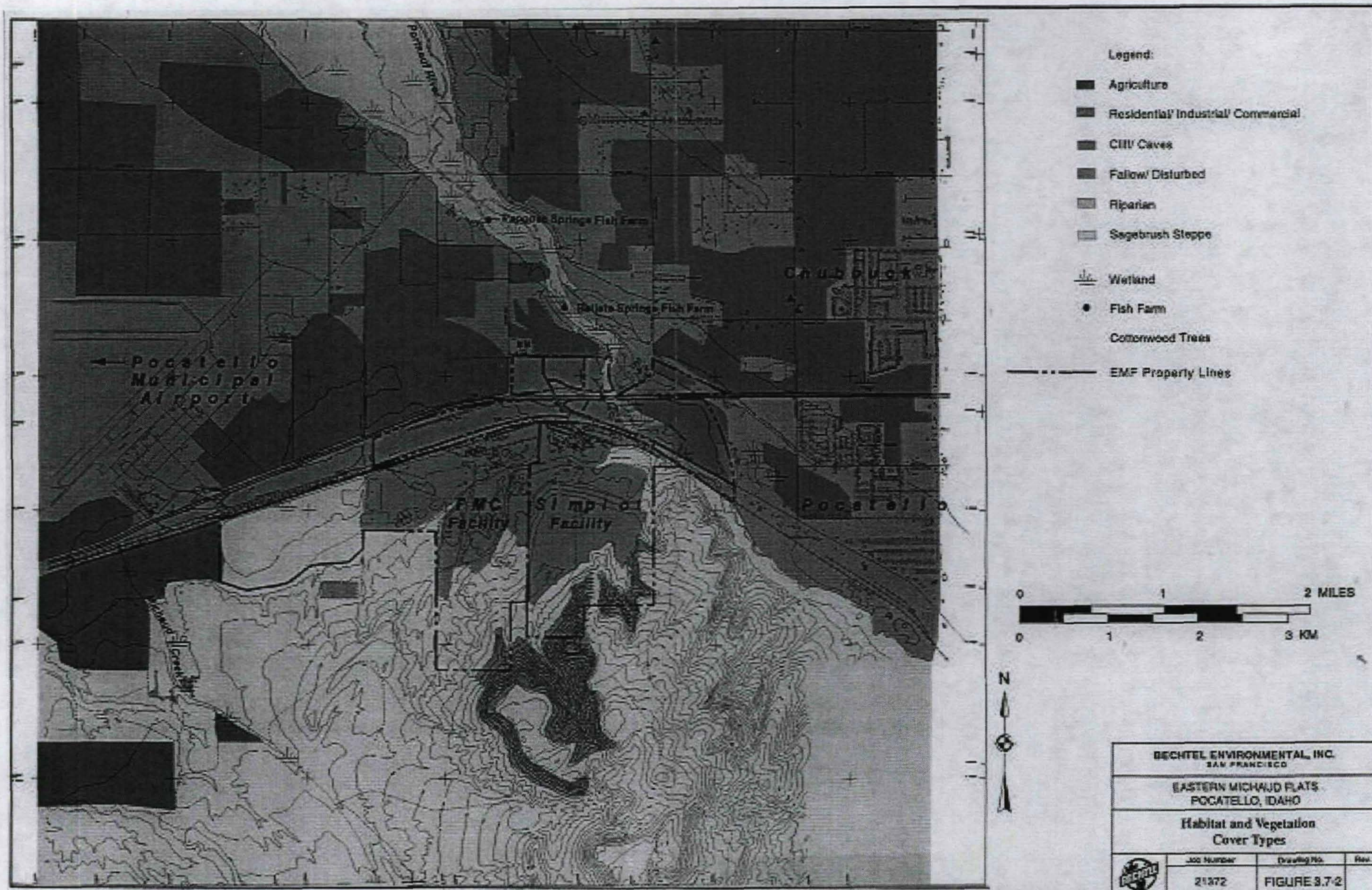
Annual production rate for the rainbow trout is higher, since rearing coho salmon is still in the experimental stage. The fish facility at the Rowland creamery uses water from Batiste Spring and other groundwater discharged to the spring channel, and the downriver facility uses water from Papoose Spring. The fish at these facilities are fed commercially prepared fish food and sold as either fingerlings (for stocking) or at about 1 to 1.5 years of age, for processing at the food plant. Production at the two fish facilities is estimated at about 49,896 pounds (22,680 kg) per year of stockers and 9,979 pounds (45,360 kg) per year of harvest for human consumption (Marquardt, 1992).

Kokanee salmon have been reported by the Shoshone-Bannock Tribe (1992) to be present in this stretch of the Portneuf River. However, Mr. Marquardt, plant manager of Aqua Sea Inc., could not recall ever raising Kokanee salmon at either of the fish farms.

TABLE 3.7-5
GAME AND NONGAME FISH SPECIES FOUND IN THE PORTNEUF RIVER

Common Name	Scientific Name	Reference
GAME FISH		
Fish farm rainbow trout[a]	*Oncorhynchus mykiss*	Broderick et al., 1989
Wild rainbow trout	*Oncorhynchus mykiss*	Broderick et al., 1989; Shoshone-Bannock Tribe, 1992
Brown trout	*Salmo trutta*	Broderick et al., 1989; Shoshone-Bannock Tribe, 1992
Kokanee salmon[a]	*Oncorhyncus nerka*	Shoshone-Bannock Tribe, 1992
Coho salmon[a]	*Oncorhyncus kisutch*	Marquardt, 1992
Hybrid trout (Rainbow x Cutthroat)	*O. mykiss x O clarkii*	Broderick et al., 1989
Mountain whitefish	*Prosopium williamsoni*	Broderick et al., 1989; Johnson et al., 1977; Mohr, 1968; Shoshone-Bannock Tribe, 1992
Yellow perch	*Perca flavescens*	Johnson et al., 1977
Black crappie	*Pomoxis nigromaculatus*	Johnson et al., 1977
Black bullhead	*Ictalurus melas*	Johnson et al., 1977
Brown bullhead	*Ictalurus nebulosus*	Shoshone-Bannock Tribe, 1992
Channel catfish	*Ictalurus punctatus*	Shoshone-Bannock Tribe, 1992
NONGAME FISH		
Common carp	*Cyprinus carpio*	Broderick et al., 1989; Shoshone-Bannock Tribe, 1992
Large scale sucker	*Catostomus macrocheilus*	Broderick et al., 1989
Utah sucker	*Catostomus ardens*	Johnson et al., 1977; Shoshone-Bannock Tribe, 1992
Redside shiner	*Richardsonius balteatus*	Broderick et al., 1989; Mohr, 1968; Johnson et al., 1977; Shoshone-Bannock Tribe, 1992
Longnose dace	*Rhinichthys cataractae*	Broderick et al., 1989; Mohr, 1968
Speckled dace	*Rhinichthys osculus*	Broderick et al., 1989; Mohr, 1968
Mottled sculpin	*Cottus bairdi*	Broderick et al., 1989; Shoshone-Bannock Tribe, 1992
Utah chub	*Gila atraria*	Johnson et al., 1977; Shoshone-Bannock Tribe, 1992

Note: [a] Fish farm escapees that are occasionally found in the Portneuf River.



Papoose Springs Fish Farm
Batiste Springs Fish Farm
Chubbuck
Pocatello Municipal Airport
FMC Facility
Simplot Facility
Pocatello
Legend:
Agriculture
Residential/ Industrial/ Commercial
Cliff/ Caves
Fallow/ Disturbed
Riparian
Sagebrush Steppe
Wetland
Fish Farm
Cottonwood Trees
EMF Property Lines
0 1 2 MILES
0 1 2 3 KM
N
BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO
EASTERN MICHAUD FLATS
POCATELLO, IDAHO
Habitat and Vegetation
Cover Types
Job Number
21372
Drawing No.
FIGURE 3.7-2
Rev.

4.5 SURFACE WATER AND SEDIMENTS

This section provides an assessment of the nature and extent of EMF-related constituents in surface water, sediments, and springs associated with the river. The assessment is based on the results of the surface water and sediment sampling performed as part of the RI. The sampling and analysis program for the surface water and sediment investigation was described in Section 2.4 of this report.

Phase I consisted of sampling at locations ranging from the City of Pocatello, approximately 6 miles (9.6 km) upstream of the EMF facilities, to River Mile 10, approximately 4 miles (6.4 km) downstream of the EMF facilities (Figures 4.5-1 and 4.5-1a to g). Water samples were collected from 27 locations during four events: July 1992, October 1992, February 1993, and April 1993; sediments were collected in July 1992. Flow gaging in the Portneuf River was performed at selected locations during these sampling events. Samples collected at nine of the 27 locations were spring samples as opposed to river water samples, and thus reflected groundwater chemistry. The springs included Batiste and Swanson Road Springs also sampled as part of the groundwater monitoring program discussed in Section 4.4.

Phase II consisted of surface water and sediment sampling at locations in the immediate vicinity of the FMC IWW ditch outfall (Figure 4.5-1h) and sediment sampling in the Fort Hall Bottoms (approximately 5.5 miles [8.8 km] downstream form the EMF facilities) (Figure 4.5-1i). All Phase I and II samples were analyzed for a suite of metals, nutrients, common ions, fluoride and radiological parameters.

Because the EMF facilities have been in operation for more than 40 years, it was assumed that cumulative effects of chemicals transported to the river from the EMF facilities would be evident in sediments collected along the Portneuf River near the EMF facilities. When measureable impact on sediment proved limited to the immediate area of the FMC IWW ditch outfall, and there was no meausurable impact on surface water, another investigation was initiated at EPA's request at the confluence of the Portneuf River and the American Falls Reservoir. Results of this investigation are presented in Section 4.6, Ecology.

Surface Water and Sediment Investigation Objectives

The objectives of the surface water and sediment investigation were:

- To assess the nature and extent of any EMF-related impacts on the Portneuf River water and sediments.
- To evaluate the pathways by which chemicals originating from the EMF facilities may be transported to the river. The four potential pathways are:
  - Direct aerial deposition,
  - Surface runoff from impacted surface soils,
  - Discharge of impacted groundwater
  - Direct discharge (i.e., the IWW ditch outfall)

Overview of Findings

The major findings of the surface water and sediment investigation are listed below. Data evaluation methods used to arrive at these findings included comparisons of upstream and downstream results; comparison of results with soil and groundwater representative levels; and application of various statistical techniques, including cluster analyses, t-tests, and non-parametric ANOVAs.

- There were no measureable effects on surface water chemistry directly attributable to the EMF facilities. Surface water upstream from the EMF facilities contained lower sulfate, nitrate, and total phosphorus concentrations than river water downstream of the facilities; however, this result is explained by the high rate of groundwater unaffected by the EMF facilities discharging to the river (200 cfs between the EMF facilities and Siphon Road). In addition, there are other documented sources of nitrate, sulfate, and total phosphorus to the Portneuf River downstream from the EMF facilities.
- EMF effects on sediments were limited to samples SD17 and SD17A, collected at the IWW ditch outfall.
- Because there were no measurable effects on sediment chemistry attributable to the EMF facilities beyond the localized area of the IWW ditch outfall, aerial deposition and surface soil runoff are not significant transport pathways to surface water and sediment. This

conclusion is further supported by results for specific samples most likely to reflect the influences of these pathways (sediment samples SD9 and SD11).

- Consistent with Section 4.4 findings, groundwater discharging at Batiste and Swanson Road Springs contained EMF-related constituents. Arsenic, barium, boron, and lithium, and ammonia, nitrate, total phosphorus, and sulfate exceeded representative groundwater levels in one or more samples from these springs. However, the average concentrations of these chemicals at these springs were not significantly above representative groundwater levels. In fact, average concentrations of arsenic and nitrate were below representative groundwater levels. None of these constituents were identified at elevated levels in samples collected immediately downstream of Batiste or Swanson Road Spring.
- Constituent concentrations were not elevated in river water at the IWW ditch outfall. (A comparison of data for groundwater from FMC production well FMC-1, the source of the non-contact cooling water discharged to the IWW ditch; water from the IWW ditch; and surface water collected at the IWW ditch outfall is presented in Tables 4.5-1 and 4.5-1a).

Section Content and Organization

An overview of the organization and conclusions of Section 4.5 is provided on Figure 4.5-2. The results, data evaluation methods, and findings of the surface water investigation are presented in Section 4.5.1. Section 4.5.2 presents the results, data evaluation methods, and findings for sediment.

RI surface water and sediment sampling results are presented in Appendix U.

CHARACTERIZATION OF SURFACE WATER (SECTION 4.5.1)	Overall Discussion (Section 4.5.1.1) • There do not appear to be any representative level exceedances downstream directly attributable to to the EMF facilities despite above-representative levels of EMF-related constituents detected at Batiste and Swanson Road Springs.	Statistical Methods (Section 4.5.1.2) • The springs can be divided into groups based on spring water chemistry. Batiste and Swanson Road Spring chemistry are unique. • The general chemistry of the groundwater discharging to the river is different from that of the upstream river water. As expected, downstream river water is more similar to groundwater than to the upstream water under low-flow conditions. • Mixing zone effects were generally not apparent downstream of the EMF facilities.	Detailed Discussion (Section 4.5.1.3) • This section provides a chemical-by-chemical comparison of down-stream river water with groundwater and upstream river water.
CHARACTERIZATION OF SEDIMENTS (SECTION 4.5.2)	Overall Discussion (Section 4.5.2.1) • The only sediment samples which reflect EMF influences are SD17 and SD17A collected at the FMC IWW outfall. • Above-representative level constituent concentrations were not detected in downstream samples	Statistical Methods (Section 4.5.2.2) • With few exceptions, near-site, spring and downstream sediment constituent concentrations were not statistically different from upstream concentrations. Constituents for which statistical differences were found were often higher upstream from the EMF facilities than they were downstream. • Samples from the IWW outfall (SD17 and SD17A) were very different from all other samples, underscoring the conclusion that SD17 reflects IWW ditch influence and that measurable effects of this influence are localized at the outfall.	Detailed Discussion (Section 4.5.2.3, River Sediments and Section 4.5.2.4, Spring Sediments) • Upstream sediment constituent concentrations were very similar to soil representative levels. • These sections provide a sample-by-sample discussion of the river and spring sediment sample analytical data. • Aerial deposition and surface water runoff do not appear to be significant transport pathways as evidenced by the results for sediment samples SD9 and SD11.

FIGURE 4.5-2
OVERVIEW OF SURFACE WATER AND SEDIMENT INVESTIGATION

4.5.1 NATURE AND EXTENT OF EMF-RELATED CONSTITUENTS IN SURFACE WATER

The nature and extent of EMF-related constituents in surface water were investigated by two methods. The first was a multivariate statistical method called cluster analysis. This was performed to assess the degree of dissimilarity of samples collected beyond the potential influence of the EMF facilities with those collected downstream. The second was a chemical-by-chemical comparison of constituent concentrations with representative groundwater concentrations and upstream surface water concentrations. During low-flow conditions along the Portneuf River, the comparison of downstream surface water samples with groundwater representative levels is valid due to the relatively large volume of groundwater discharged to the river downstream from the EMF facilities. Three sampling events occurred during low-flow conditions (less than one-half average flow), and one event occurred during above-average flow conditions. For the purposes of this investigation, gaining reach river water quality was compared to background groundwater chemistries as defined in Section 4.4, since groundwater from all three hydrogeochemical regimes discharges to the river.

The results of these comparisons and analyses were used along with the understanding of surface water hydrology presented in Section 3.3 and knowledge of EMF and non-EMF potential sources to draw conclusions as to the nature and extent of EMF effects on surface water.

4.5.1.1 Surface Water Chemistry Data – Overall Results

The following discussion of surface water chemistry within the EMF study area draws on the data summarized in Tables 4.5-2 through 4.5-8. Appendix U presents metals analysis results with validation qualifiers for individual samples collected during each round of RI sampling.

Antimony, beryllium, cadmium, chromium, cobalt, lead, molybdenum, nickel, selenium, silver, thallium, and zinc were either not detected in any of the water samples or were detected only in concentrations at their detection limits. These constituents are not discussed further in this section. Mercury was reported by the laboratory to be present in several surface water samples at levels just above its detection level. However, these results are considered to be false-positives as discussed in Section 4.1.

Total aluminum, iron, and manganese were detected above representative groundwater levels at a number of locations. However, their concentrations correlate well with turbidity and river discharge, and are thus likely indicative of naturally occurring suspended solids in the river system. Nevertheless, these elements are also discussed in Section 4.5.1.3.

Arsenic, ammonia, barium, boron, fluoride, lithium, nitrate, phosphorus, and sulfate were found at concentrations above representative groundwater levels at Batiste Spring (SW14) and Swanson Road Spring (SW15). Although some of these chemicals exceeded representative groundwater levels in one or more downstream samples, the exceedances do not appear to be attributable to EMF. A detailed discussion of the above-listed constituents is provided in Section 4.5.1.3.

Copper was detected at mean concentrations in excess of the representative groundwater concentrations at the IWW ditch outfall (0.015 mg/l total copper), but these levels did not exceed the mean concentrations for upstream sampling station SW19.

4.5.1.2 Surface Water Statistical Analyses – Methods and Results

Data presented in Tables 4.5-2 through 4.5-7 are mean concentrations of analytes. The mean concentrations at each sampling station were calculated using results from four samples collected over a one year period, when available. Constituents reported as not detected were not used in the calculation of mean concentrations. Omission of the nondetects when calculating mean concentrations is considered a conservative approach because it typically leads to higher mean concentrations for comparison with the representative groundwater concentrations, which were calculated using the detection limit values. This approach exaggerates surface water concentrations with respect to groundwater concentrations.

A multivariate statistical analysis called cluster analysis was used to investigate the possibility that surface water samples collected within the channel of the Portneuf River were within the "mixing zone" of nearby discharges (e.g., STP), and thus were not representative of ambient Portneuf River (Park, 1974). Cluster analysis was also used to investigate groupings or clusters within the dataset that are not immediately evident by inspection. Cluster analysis is used for investigating patterns in datasets using multiple variables concurrently.

For this analysis, constituents displaying the highest degree of dissimilarity were used. These were: calcium, arsenic, barium, bicarbonate, fluoride, potassium, lithium, magnesium, sodium, ammonia, nitrate, orthophosphate, total phosphorus, and sulfate. This group of constituents includes those transported via various pathways. Use of these variables increased the overall contrast between samples or sample "clusters".

The cluster analysis confirmed that certain springs form distinct groups. Samples SW13 (STP), SW9 (FMC Employee Park), SW15 (Swanson Road Spring), and SW14 (Batiste Spring) all define separate clusters, indicating unique chemistry associated with each spring. Springs located further north (SW2, SW5, SW7, SW6, and SW4) are similar to each other and dissimilar from the other springs. SW9 is more similar to the northern springs, and less similar to the springs near the EMF facilities and the STP.

This analysis also indicates that spring chemistry is distinct from the river chemistry, regardless of season or river discharge. Samples from SW11, in the spring drainage downstream of Batiste Spring, are more similar to river samples than the Batiste Spring samples. In other words, EMF-related influences detected at Batiste Spring are no longer apparent in the surface water along the spring drainage several hundred feet downstream. This finding is not unexpected, because the drainage channel from Batiste Spring triples in flow rate between the spring house (SW14) and the point at which it meets the main river channel, providing ample water to dilute the EMF-influenced water discharged at Batiste Spring.

For some sampling events, SW11 is more similar to SW10 or SW12, both downstream river sampling points. This indicates that the gaining river water is more similar to representative groundwater than the upstream river water. This finding is expected because the river gains more than 200 cfs from groundwater discharge, and during low-flow conditions, upstream river flow is only 20 to 150 cfs. In general, samples from unaffected springs are similar to the gaining reach river water during low flow events. This provides further support to the conclusion that gaining reach river water is more similar to groundwater chemistry than it is to upstream surface water chemistry. These results mean that, under low-flow conditions, comparing downstream surface water chemistry with background groundwater chemistry is a valid means of assessing potential EMF-related influences on surface water quality in the river.

Samples from the upstream river reach form four distinct groups, one for each sampling event. This clustering indicates that the upstream water chemistry is fairly consistent throughout the losing river reach, up to station SW16. SW17, near the FMC IWW ditch outfall, is not similar to any other river or spring samples, but the SW17 samples are not similar to one another, indicating temporal variation. The sample collected during April 1993 at SW25, furthest upstream from the EMF facilities, is markedly different from samples collected further downstream. This difference indicates there may have been a point source impact at SW25 during this sampling event, but there is not a measurable impact further downstream.

The April 1993 results are unique along the entire river reach in that the upstream samples (excluding SW25) and downstream samples are more similar to each other than the upstream versus downstream samples from low river discharge sampling events. This is expected because the river had very high flows during the April 1993 sampling event, and any influences from groundwater along the gaining reach will be lessened by high river flow associated with regional surface water runoff from snow melt and spring rains.

Mixing Zone Effects. The cluster analysis supports the conclusion (1) that certain sample locations were subject to mixing zone effects, and (2) that mixing zone effects were not prevalent throughout the year nor were these effects dominant in the overall sample network. To illustrate, one prediction is that the water samples collected at a location influenced by "mixing zone effects" would be similar to the point discharge water chemistry, and unlike the upstream river water. Another prediction is that the water collected from a mixing zone should have a distinct water chemistry, especially if the point discharge water chemistry is distinctly different from river water chemistry. However, such predictions were not borne out by the data except under low flow conditions at one sampling location (SW5).

During low flow periods, there appears to have been a "mixing zone effect" observed at SW5, located in the river channel downstream from the Papoose Springs Fish Farm. During low flow periods, SW5 samples were more similar to the Papoose Spring samples SW7 and SW6. During high river flow in April 1993, SW5 was more similar to river stations SW1 and SW3A. These results indicate that SW5 is more representative of the Papoose Spring water than river water during low flow conditions. However, during higher flow, SW5 is more representative of river water. Mixing zone effects were not as obvious at SW10, located downstream from the outfall of Batiste Springs, or at SW12, at the STP outfall. In fact, SW10 was not similar to either Batiste Spring sampling location SW11 and SW14, but in several instances, the SW10 samples were most closely linked to SW12, near the STP outfall. This pattern indicates, that if there is a water chemistry signature from the STP discharge, it is observable at SW10.

Mixing zone effects were only observed at SW5 under low flow conditions in the river; the constituents discharging from Papoose Spring and influencing SW5 under these conditions are not associated with the EMF facility. It was demonstrated in Section 3.3 that groundwater from the EMF facilities does not flow toward Papoose Spring. With these preceding exceptions, the samples collected within the Portneuf River are, consequently, not biased by influences from nearby point source discharges. Thus, they adequately document ambient water quality within the river at the time of sampling.

4.5.1.3 Surface Water – Detailed Discussion

A detailed discussion of the surface water sampling results with particular focus on those constituents that exceeded upstream mean concentrations or the representative groundwater concentrations is provided below. The discussion provides additional support for conclusions presented in Sections 4.5.1.1 and 4.5.1.2 about the nature and extent of EMF-related constituents in surface water.

This section focuses on the constituents detected at elevated concentrations in Batiste Spring and Swanson Road Spring (i.e., those constituents known to be transported from the EMF source areas to surface waters). These constituents include ammonia, arsenic, barium, boron, fluoride, nitrate, lithium, total phosphorus, and sulfate. Copper was detected above groundwater representative levels at the IWW ditch outfall sampling point in the river, and is included in the detailed discussion of river sampling results. Vanadium is discussed because results from the July 1992 sampling event appear to be affected by laboratory or field artifacts, not because vanadium was detected at elevated concentrations in the groundwater pathway or the IWW ditch discharge. Aluminum, iron, and manganese in the river samples are also discussed, although these constituents correlate with turbidity and river discharge and are not believed to be associated with the EMF facilities.

Metals

Arsenic in Springs. Arsenic was detected in at least two rounds of sampling for all spring and spring-drainage sampling points. Highest mean arsenic concentrations were at Batiste Spring (0.032 mg/l dissolved) and Swanson Road Spring (0.010 mg/l dissolved) (Table 4.5-2). These mean concentrations were higher than or equal to the representative concentrations for groundwater related to the discharges at Batiste Spring and Swanson Road Spring (0.018 mg/l Bannock Range regime associated with Batiste Spring, and 0.0104 mg/l Portneuf River Valley regime associated with Swanson Road Spring). The highest mean arsenic concentrations for the East Side System and Papoose System springs and spring-drainage sampling points were below representative groundwater levels.

The maximum arsenic concentration at Swanson Road Spring (0.0134 mg/l dissolved) occurred during the October 1992 sampling event. The maximum arsenic concentrations for Batiste Spring (0.057 mg/l dissolved; 0.032 mg/l total) occurred during the April 1993 sampling event. However, the dissolved arsenic concentration is questionable and likely biased-high because it was greater than the total arsenic concentration.

At sampling point SW11, arsenic was detected during only two events. The maximum concentration (0.008 mg/l total) was detected during April 1993.

Arsenic in River. Arsenic concentrations in river water were low compared with concentrations in representative groundwater (Table 4.5-3). Arsenic was detected in at least two rounds of sampling for all river sampling stations except SW16 (and SW18, which was only sampled once). Mean total arsenic concentrations were marginally higher in the losing-reach group of river sampling stations (0.006 mg/l) than in the gaining-reach group (0.004 mg/l). Highest individual station means were found in the four losing-reach stations, SW20 through SW18 plus SW16. These four river sampling stations, along with SW17, are nearest to and downstream of the EMF facilities. However, the means calculated for these sampling points are based on two samples rather than the four taken. The two samples not used were below detection limits or rejected in the validation process. If mean concentrations were calculated using all four samples, the mean arsenic concentrations would have been considerably lower at these four sampling stations. In the gaining reach, arsenic concentrations in river water were comparable to concentrations in representative groundwater.

Barium in Springs. Barium concentrations in springs were comparable to representative groundwater levels. Barium was detected routinely in samples from spring and spring-drainage sampling points. The mean barium concentrations ranged from 0.064 to 0.123 mg/l, which are less than the representative groundwater levels for all sampling points except Twenty Springs-East (SW02). The mean total barium concentration at Twenty Springs-East is 0.760 mg/l. This mean concentration may have been artificially high because of a single measurement (2.81 mg/l during July 1992). Using only subsequent sampling data to calculate the mean total barium concentration for SW02 yields a value of 0.077 mg/l. This lower mean concentration is consistent with mean concentrations for other springs.

Barium in River. Barium was detected routinely in samples from all river sampling stations. However, all mean barium concentrations were below the representative levels for groundwater (0.12 mg/l, Bannock Range; and 0.17 mg/l, Portneuf River Valley). The widespread distribution of this parameter suggests that barium is naturally occurring in river water.

Boron in Springs. Boron was detected in at least two rounds of sampling for all spring and spring-drainage sampling points. Highest mean boron concentrations were at SW15, Swanson Road Spring (0.28 mg/l total and 0.21 mg/l dissolved), and SW13, the springs near the STP (0.24 mg/l total and 0.22 mg/l dissolved). However, these concentrations are near or below the representative groundwater levels for the Portneuf River Valley hydrogeochemical regime (0.25 mg/l). In addition, Batiste Spring (SW14), Batiste Springs drainage (SW11), and Papoose Spring (SW07) also had mean boron concentrations below representative levels (0.308 mg/l, Bannock Range). Since boron was found in all four spring groups at similar levels and only two springs discharge groundwater affected by EMF-related activities, the boron was most likely naturally occurring at the levels noted above.

Boron in River. Boron was detected in at least two rounds of sampling at all river sampling stations. The highest mean boron concentrations were detected in the Phase I samples at SW17 (0.38 mg/l total and 0.23 mg/l dissolved) (Table 4.5-1). At sampling stations SW25, SW24, SW23, SW19, SW16, SW12, and SW10 mean total boron concentrations ranged from 0.27 to 0.33 mg/l, compared with the representative levels for groundwater of 0.31 mg/l for Bannock Range and 0.25 mg/l for Portneuf River Valley (Table 4.5-3). The maximum boron concentration detected during subsequent sampling was 0.11 mg/l. In general, the boron detected in the river samples was not elevated downstream from EMF discharges.

Copper in River. Mean copper concentrations in Table 4.5-3 typically represent one or two samples at each station in which copper was reported. As discussed in Section 4.4, the groundwater pathway is not transporting copper to surface waters, nor is copper an EMF-related constituent at source areas.

For river sampling station SW17 at the FMC IWW ditch outfall, mean Phase I copper concentrations (0.015 mg/l total and 0.011 mg/l dissolved) were approximately two times the mean concentration for all river samples (0.007 mg/l) for both total and dissolved copper. The Phase II sampling data at SW17 had a mean copper concentration of 0.007 mg/l, with values ranging from ND to 0.011 mg/l. The Phase I SW17 results indicate that the IWW ditch was transporting groundwater containing representative levels of copper. Additionally, there was a higher copper concentration detected at an upstream station (0.022 mg/l at SW19), indicating copper concentrations in surface are variable.

Lithium in Springs. Lithium was detected in at least three rounds of sampling of all spring and spring-drainage sampling points. The highest mean lithium concentrations were at SW14, Batiste Spring (0.051 mg/l total and 0.053 mg/l dissolved; Table 4.5-2). These concentrations were above the representative level for Bannock Range groundwater (0.0165 mg/l).

Lithium concentrations for the Papoose Spring system (SW05, SW06, SW07) ranged from not detected to 0.038 mg/l (total) and from 0.024 to 0.039 mg/l (dissolved), greater than the representative level for Bannock Range groundwater (0.0165 mg/l), but less than the Michaud Flats and Portneuf River Valley representative levels (0.040 and 0.061 mg/l). Mean lithium concentrations for Swanson Road Spring (SW15) and East Side springs (SW09 and SW13) ranged from 0.023 to 0.044 mg/l, and were comparable to the representative level (0.040 mg/l) for Portneuf River Valley representative groundwater.

Lithium levels were higher in river water upstream of the EMF operations areas (SW23 to SW25) than in springs (Tables 4.5-2 and 4.5-3). Figure 4.5-5 illustrates this trend in lithium concentrations for spring sampling points and for river sampling stations.

Lithium concentrations for other springs in river water upstream of EMF facilities were also higher than the representative level for groundwater (0.0165 mg/l, Bannock Range; and 0.040 mg/l, Portneuf River Valley), but they most likely represent naturally occurring levels, similar to higher lithium concentrations.

Lithium in River. Lithium was detected in samples from all river sampling stations except gaining-reach stations SW12E (dissolved lithium) and SW7E (total lithium). Mean lithium concentrations for all river sampling stations were comparable to or higher than the representative levels for groundwater. Upstream from the EMF facilities, lithium was present at higher levels in river water than in representative groundwater, and its presence does not represent an impact from the EMF facilities.

As shown in Table 4.5-3, mean lithium concentrations in samples from river sampling stations decreased from a high value of 0.058 mg/l total lithium at SW25 and SW24 to a mean concentration of 0.037 mg/l (total and dissolved) for lithium in the gaining-reach sampling stations. Figure 4.5-3 illustrates this trend in lithium concentrations.

Vanadium in Springs. Vanadium concentrations were near detection limits in most samples from spring and spring-drainage sampling points in the EMF study area. These concentrations were below the representative levels for groundwater (0.10 mg/l, Bannock Range; and 0.199 mg/l, Portneuf River Valley).

The mean vanadium concentrations presented in Table 4.5-2 are not a clear representation of vanadium detected over four rounds of surface water sampling, as concentrations varied by two orders of magnitude. During the initial round of surface water sampling in July 1992, reported vanadium concentrations for spring-related sampling points (0.04 to 0.13 mg/l) were much higher than those reported for subsequent rounds of sampling (maximum 0.011 mg/l). During the April 1993 round of sampling, vanadium was not detected in any surface water sample.

Vanadium concentrations are illustrated for a sampling point from each of the four spring systems in Figure 4.5-4. The higher vanadium concentrations detected among the samples collected during the July 1992 sampling event may reflect the influence of field or laboratory procedures which resulted in artificially high vanadium concentrations.

Vanadium in River. Vanadium concentrations were near detection limits in samples from river sampling stations in the EMF study area. There was a small increase in the mean vanadium concentrations from upstream to downstream; however, the vanadium concentrations in gaining reach river water were below the representative levels for groundwater (0.100 mg/l, Bannock Range; and 0.199 mg/l, Portneuf River Valley).

The mean vanadium concentrations presented in Table 4.5-3 are not a clear representation of vanadium detected over four rounds of surface water sampling, as concentrations varied by an order of magnitude. During the July 1992 sampling event, the reported vanadium concentrations for six river sampling stations were much higher (0.04 to 0.08 mg/l) than for subsequent rounds of sampling (maximum 0.003 mg/l). Vanadium was reported as "not detected" for the remaining nine river sampling stations during the July 1992 sampling event with detection limits ranging from 0.015 to 0.190 mg/l. During the April 1993 round of sampling, vanadium was not detected in any surface water samples, and sample detection limits were 0.004 mg/l.

The vanadium concentrations for river sampling stations are illustrated in Figure 4.5-5. Based on four rounds of sampling, it is possible that these concentrations are associated with a seasonal fluctuation in concentrations. However, the "trend" is more likely an effect of field or laboratory procedures which resulted in artificially high vanadium concentrations for July 1992.

Aluminum in River. Total aluminum was detected routinely in samples from the majority of river sampling stations in the losing reach of the Portneuf River: SW25, SW24, SW23, SW20, SW19, and SW16. Aluminum concentrations in samples from SW16 and SW25 are illustrated in Figure 4.5-6. At other sampling locations, total aluminum (Table 4.5-3) was detected in only one or two samples. Dissolved aluminum (Table 4.5-3) was detected in only one or two samples collected from each location.

The presence of aluminum in surface water samples as total aluminum rather than dissolved aluminum is generally an indicator of a turbid water sample due to the presence of suspended solids. Total aluminum was detected in all river samples for April 1993 when riverflow was at a maximum for all sampling events.

Iron in River. Total iron was detected in river water samples as a result of suspended solids. Seasonally high levels of total iron resulted from increased turbidity that occurred during periods of increased flow in the Portneuf River. Total iron was routinely detected at all river sampling stations except SW25 and was present at higher concentrations in the losing reach than in the gaining reach of the Portneuf River.

Mean dissolved iron concentrations (Table 4.5-3) for all the river sampling stations and mean total iron for SW25 reflect only one or two samples in which iron was reported. Dissolved iron was near detection limits in all river water samples from the EMF study area.

The mean total iron concentrations are not a clear representation of iron detected over four rounds of surface water sampling as concentrations varied by two orders of magnitude. Total iron concentrations ranged from below detection to 0.32 mg/l for all river samples for the first three rounds of sampling (Appendix U). However, total iron concentrations ranged from 0.94 to 1.73 mg/l in river water samples during the April 1993 sampling event. Figure 4.5-7 illustrates this trend in total iron concentrations for SW22 and SW16 in the losing reach, and SW10 and SW08 in the gaining reach.

Comparison of group means provided in Table 4.5-3 for losing-reach versus gaining-reach river stations shows that during both the low flow (first three events) and high flow (April 1993) sampling events, iron concentration were greater in the losing-reach than the gaining-reach.

Manganese in River. Total manganese was routinely detected at all river sampling stations except SW21, and was present at higher concentrations in the losing reach than in the gaining reach of the Portneuf River. For the July 1992 round of sampling, manganese was reported in only two samples (0.037 mg/l for SW20 and 0.012 mg/l for SW01).

Total manganese was detected in river water samples due to the presence of suspended solids; manganese was not present in filtered river water samples. Seasonally high levels of total manganese resulted from increased turbidity which occurred during periods of increased flow in the Portneuf River.

Similar to aluminum and iron, the presence of manganese in surface water samples as total manganese rather than dissolved manganese was generally an indicator of a turbid water sample. The conclusion drawn from this observation is further supported by comparing total manganese concentrations with river flow. Total manganese was detected in all river samples for April 1993, when river flow was at a maximum for all sampling events.

The mean total manganese concentrations presented in Table 4.5-3 are not a clear representation of manganese detected over four rounds of surface water sampling, as concentrations increased twofold to fourfold for the April 1993 sampling event. Total manganese concentrations ranged from below detection to 0.014 mg/l. However, total manganese concentrations ranged from 0.037 to 0.062 mg/l during the April 1993 sampling event. The total manganese concentrations for sampling stations SW25, SW16, SW12, and SW03 are illustrated in Figure 4.5-8.

Comparison of group means provided in Table 4.5-3 for losing-reach versus gaining-reach river sampling stations shows that total manganese concentrations were approximately the same for the losing-reach and gaining-reach river sampling stations.

Nutrients, Fluoride, and Sulfate

Ammonia in River and Springs. Mean ammonia concentrations were at representative groundwater levels (0.5 mg/l) or below detection levels in samples collected upstream from the EMF site. Ammonia was detected in Batiste Spring as part of the groundwater monitoring program. Downstream from the EMF site, in the gaining reach of the river, mean ammonia concentrations were highest at SW12 (3.4 mg/l) and decreased further downstream. Elevated concentrations of ammonia at SW12 were attributed to the STP discharge. These observations agree with the STP bioassessment of the Portneuf River (City of Pocatello, 1989). The ammonia introduced into the surface water via Batiste Spring was intermittent, and samples collected along the spring drainage channel at SW11 did not contain detectable levels of ammonia, indicating the total ammonia contribution at Batiste Spring was not high enough to be measurable at points downstream.

Nitrate in Springs. Nitrate was detected at spring sampling stations at mean concentrations ranging from 1.40 to 4.44 mg/l (Table 4.5-4 and Figure 4.5-9). The highest mean nitrate concentrations were found at Batiste Spring (4.44 mg/l), Swanson Road Spring (2.64 mg/l), STP Spring (3.41 mg/l), and Papoose Spring (2.98 mg/l) (Table 4.5-4). Mean nitrate concentrations were lower at sampling points in the drainage channels of Batiste Spring and Papoose Spring (Table 4.5-4).

Note that the STP spring (SW13) has Portneuf River Valley hydrogeochemical characteristics and is located along the east bank of the river. EMF-related groundwater does not impact this spring.

Individual nitrate results for each spring-related sampling point for each sampling round during the RI are shown in Figure 4.5-10. Nitrate concentrations for the springs in the East Side System were generally above 3 mg/l. Slightly elevated nitrate concentrations were detected at the spring within the STP operations area (SW13).

The nitrate concentration of 11 mg/l at Batiste Spring in the April 1993 sample may represent a unique or intermittent event that impacted groundwater and, subsequently, Batiste Spring (Figure 4.5-10). During April 1993, total phosphorus and sulfate at Batiste Spring were also elevated above levels found in previous rounds of sampling (Appendix U).

Nitrate in River. Nitrate concentrations were consistently higher in the gaining reach than in the losing reach of the river (Table 4.5-5). Representative groundwater is a potential source of nitrate in the gaining reach (Figure 4.5-11), due to the relatively high levels of nitrate found in background Michaud Flats and Portneuf River Valley groundwater. The representative nitrate concentrations were 5.52 mg/l and 4.0 mg/l in these two hydrogeochemical regimes.

To the east of the Portneuf River, nitrate in groundwater (3.0 to 3.4 mg/l in Wells 512 and 513) may be related to agricultural activities on the Portneuf River floodplain or to private septic systems. To the west of the river, similar nitrate levels might also be associated with agricultural activities throughout the Michaud Flats, private septic systems, and the land application of sewage sludge in an area north of I-86.

River station SW17 had consistently higher concentrations of nitrate than other losing-reach stations (up to 1.62 mg/l in October 1992). Nitrate levels in the river at SW17 were attributed to the FMC IWW ditch outfall. The maximum nitrate concentration found in a Phase II sample at SW17 was 0.72 mg/l, and the mean concentration in the Phase II samples was 0.57 mg/l. Therefore, it appears that the nitrate concentration detected at SW17 during Phase I resulted from the IWW discharge of nitrate-containing background groundwater (Tables 4.5-1 and 4.5-1a).

As shown in Figure 4.5-11, the highest nitrate levels detected for three out of the four sampling events were detected in samples collected at the downstream stations SW07E to SW01. SW01 was the furthest downstream river sampling station in the RI sampling program. During July 1992, nitrate concentrations for SW01 (2.8 mg/l) and the next station upstream, SW03 (2.7 mg/l), were high compared with other gaining-reach stations.

Water quality sampling conducted by Perry (1977) found that the annual mean concentration of nitrate-N was the greatest at Siphon Road Bridge. This location is the same as RI sampling station SW03 and was the furthest downstream location sampled during Perry's 1975 investigation.

Elevated nitrate concentrations were also detected at stations 5E and 5F (Table 4.5-4), with mean concentrations of 2.47 and 2.56 mg/l, respectively. These stations are located below the Papoose Springs Fish Farm.

In summary, non-EMF activities have increased nitrate concentrations in groundwater that discharges to the Portneuf River, thereby increasing the overall nitrate concentrations in the river. Additionally, nitrates may form as the ammonia discharged from the STP is oxidized, further increasing the nitrate concentrations downstream from the STP. Nitrates are also discharged to the river via groundwater from the EMF site; however, these nitrate loadings are not sufficient to increase the nitrate concentrations along the entire gaining reach of the river (Section 5.4).

Orthophosphate and Total Phosphorus in Springs. Mean orthophosphate and total phosphorus concentrations were at or near the detection limit (0.03 mg/l) at springs SW13, SW09, SW07, SW06, SW04, and SW02 (Figures 4.5-12 through 4.5-15). Orthophosphate concentrations in representative groundwater ranged from 0.06 mg/l to 0.27 mg/l in the three hydrogeochemical regimes. Total phosphorus ranged from 0.15 mg/l to 0.33 mg/l in the three regimes (Table 4.5-4).

Orthophosphate and total phosphorus concentrations were highest at Batiste Spring (SW14), with mean orthophosphate at 2.36 mg/l and mean total phosphorus at 2.71 mg/l. Concentrations decreased downstream along the Batiste Spring drainage channel as evidenced by the mean concentrations of 0.59 and 0.48 mg/l at SW11. Mean orthophosphate and total phosphorus concentrations at Swanson Road Spring (SW15) were 0.99 and 1.05 mg/l, respectively. These levels also exceeded representative groundwater levels.

Orthophosphate and Total Phosphorus in River. Total phosphorus and orthophosphate concentrations were higher in samples collected from the gaining river reach compared with the losing reach (Table 4.5-5 and Figures 4.5-12 through 4.5-15). Although concentrations were generally very low, total phosphorus was present in groundwater beneath the EMF operations areas. Shallow monitoring well 503 near the west bank of the Portneuf River had elevated levels of total phosphorus that can be attributed to the EMF facilities. Elevated mean total phosphorus concentrations in Swanson Road and Batiste Springs are attributed to the EMF facilities.

Relatively high mean total phosphorus concentrations (0.22 mg/l) were found at the point where Papoose Spring discharges to the Portneuf River (SW05). This sampling point is downstream of the Papoose Springs Fish Farm. As total phosphorus was not elevated in the spring (SW07) and spring drainage (SW06) above the fish farm, the total phosphorus at SW05 is attributed to the fish farm.

Individual total phosphorus results are shown in Figures 4.5-13 and 4.5-15. These figures show that total phosphorus concentrations in the gaining reach of the Portneuf River were consistently highest at SW12. This river sampling station is located at the STP discharge and is upstream from where the Batiste System discharges into the river.

Water quality sampling conducted by Perry (1977) found that Pocatello STP effluent had much higher concentrations of total phosphorus (8.2 mg/l) compared to other effluent sources to the Portneuf River.

Losing-reach sampling station SW17 had mean total phosphorus concentrations (0.64 mg/l) above those detected in samples collected at the gaining-reach river sampling stations (Table 4.5-5). The total phosphorus concentration measured at station SW17 (0.64 mg/l) was likely attributable to discharge of background groundwater and IWW ditch water that may be slightly elevated in total phosphorus. Phase II sampling conducted at SW17 showed mean total phosphorus concentrations of 0.14 mg/l, lower than the Phase I findings (Tables 4.5-1 and 4.5-1a).

Fluoride in Springs. Mean fluoride concentrations for all 12 spring sampling points ranged from 0.3 to 0.8 mg/l (Table 4.5-4). Representative groundwater fluoride concentrations were 0.6 mg/l for Bannock Range groundwater, 0.8 mg/l for Michaud Flats groundwater, and 0.41 mg/l for Portneuf River Valley groundwater. Historical analysis of fluoride in springs (Perry, et. al., 1990) indicated that the Papoose springs generally had higher fluoride than springs closer to the EMF facilities.

In characterizing the spring groups, Perry et al. (1990) found fluoride concentrations to be significant. Historically (from 1978 to 1980), fluoride concentrations were four to five times greater (1.32 mg/l) in the Papoose System compared with fluoride concentrations in the other three spring groups (0.30 to 0.44 mg/l). During the RI, the highest mean fluoride concentrations (0.7 and 0.8 mg/l) were still found in Papoose System springs. The two East Side System springs (SW13 and SW9) had fluoride concentrations in the 0.30 to 0.44 mg/l range. Mean fluoride concentrations for Batiste Spring (0.6 mg/l) and Swanson Road Spring (0.5 mg/l) were greater than the historical means for these East Side springs and were comparable to fluoride concentrations (0.5 and 0.6 mg/l) in the Papoose Springs (stations SW07, SW06, and SW05). The Papoose Spring System is not impacted by the EMF facilities

Fluoride in River. Both losing- and gaining-reach river sampling stations had fluoride concentrations below 0.5 mg/l. The Phase I sample from SW17 contained 0.7 mg/l of fluoride, similar to the fluoride levels in background groundwater that is discharged via the IWW ditch. Based on Phase I findings, the elevated fluoride level in the river at SW17 may be attributable to the IWW ditch outfall. Subsequent sampling conducted at SW17 showed a decrease in fluoride at this station with a Phase II mean concentration of 0.3 mg/l (Tables 4.5-1a and 4.5-5).

Sulfate in Springs. As indicated in Section 4.4, above-representative level mean concentrations of sulfate in Swanson Road Spring (104 mg/l) and in Batiste Spring (113 mg/l) were attributed to EMF sources (Figure 4.5-16). Sulfate concentrations were also consistently higher in gaining-reach river water (ranging from 54 to 70 mg/l) than in losing-reach river water (38 to 45 mg/l), indicating that the groundwater recharging the river contains higher sulfate concentrations than the upstream river water. However, the overall increase in sulfate concentrations downstream of the EMF facilities was not solely attributable to the EMF-derived sulfate discharges at the springs.

Sulfate in River. Figure 4.5-17 shows that sulfate concentrations in the gaining reach of the Portneuf River were generally highest at SW12 (mean concentration of 65.4 mg/l). This river sampling station is located at the STP discharge and is upstream of the Batiste Spring discharge point. The STP contributes to the higher levels of sulfate in the gaining reach of the Portneuf River.

As seen in Figure 4.5-17, river sampling station SW17 had generally higher sulfate concentrations than other losing-reach river sampling stations. The Phase I sulfate results at SW17 are indicative of the sulfate in groundwater discharged via the IWW ditch to the river. Phase II sampling indicated a mean sulfate concentration of 35 mg/l at SW17. The Phase II sulfate levels were comparable to other losing-reach river sampling stations, which ranged from 38 to 45 mg/l in Phase I.

Radiological Parameters in River and Springs

Surface water analytical results for gross alpha, gross beta, radium-226, radium-228, and uranium-233/234 are discussed in this section. Samples were also tested for uranium-235 and uranium-238, and neither isotope was detected.

To assess the nature and extent of radiological parameters in springs that could be attributed to the EMF facilities operations, sampling results from spring sampling stations were compared with each other. Since EMF-affected groundwater enters the surface water system at Swanson Road and Batiste springs, results for these two springs were compared to the other springs in the study area (Table 4.5-6).

With respect to the Portneuf River, radiological parameters in surface water samples collected from the gaining reach were compared with those collected from the losing reach. Particular consideration was given to sampling stations between SW16 and SW20 (in the vicinity of the EMF facilities), including SW17, located at the FMC outfall (Table 4.5-7). A tabulation of all radiological analyses for each surface water sample collected during the RI is presented in Appendix U.

Gross alpha, radium-226, and radium-228 activities in springs and spring drainages revealed no discernible trends that would indicate potential anthropogenic impacts. The maximum gross alpha activity among all of the springs was detected at SW07 (Papoose Spring) at an activity of 8.84 ± 2.30 ρCi/l. Gross alpha activity in Batiste and Swanson Road Springs was comparable to gross alpha activity in other springs.

Radium-226 was detected in three samples from SW07, with activity ranging from 1.40 ± 0.38 ρCi/l to 1.93 ± 0.52 ρCi/l. A radium-226 activity of 5.20 ± 0.26 ρCi/l was detected in SW05 during the October 1992 sampling event. Radium-226 was also detected at SW11 at an activity of 2.60 ± 0.40ρCi/l and at SW15 with activity measurements of 1.50 ± 0.62ρCi/l and 1.82 ± 0.25 ρCi/l.

Radium-228 was not detected at SW14, SW11, and SW09. In other spring sampling locations, radium-228 was detected in at least one round. At SW15, radium-228 activity was comparable to the activity detected at other spring sample stations. The highest activities of radium-228 were measured at SW04 (3.5 ± 0.9 ρCi/l) and SW02 (5.3 ± 1.2 ρCi/l).

Gross beta radiation was detected at every spring during every round of sampling. No single sampling event consistently exhibited the highest gross beta activities. Most if not all gross beta radiation in spring samples are believed to be attributable to potassium-40 (K^{40}), a beta emitter. Using the detected concentration of potassium, the activity of K^{40} was estimated for each sample. The natural radioactive decay calculated from K^{40}-derived beta emissions as a percentage of the gross beta emissions measured in the spring samples is presented in Table 4.5-8.

Samples from selected springs (SW14, SW13, and SW05) were analyzed for uranium isotopes during the February 1993 round of sampling only. Uranium-233/234 was detected in all three samples at similar levels (1.08 ± 0.27, 1.67 ± 0.52, 1.19 ± 0.32 ρCi/l, respectively). SW14 (Batiste Spring) is known to be impacted by EMF-related constituents and the other two springs are not impacted. The levels of uranium-233/234 detected in all three springs are considered representative of unimpacted groundwaters. Uranium-235 and uranium-238 were not detected.

Gross alpha radiation was detected at all river sampling station sampling points sampled during the February 1993 round of sampling (Table 4.5-7). Gross alpha radiation was also detected in two or three rounds of sampling at SW25, SW23, SW22, SW20, SW19, SW16, and at all downstream river sampling stations.

Gross beta activities showed moderate variations from station to station, with no discernible trend indicating anthropogenic impacts. Gross beta radiation at river sampling stations was detected at every sampling point during every round of sampling, with the exception of SW21 during April 1993. Over three sampling events, upstream river stations had higher activity than downstream stations. The two highest measurements of gross beta activity (12.00 ± 2.00 and 13.80 ± 4.31 ρCi/l) were at SW01 and SW23, respectively. However, these two stations also had the lowest activities of gross beta in other rounds of sampling. In general, gross beta levels appeared to decrease from the furthest upstream river location (SW25) to the furthest downstream locations (SW03 and SW01).

As in spring samples, a large percentage of gross beta radiation in river water samples is attributable to the natural abundance of K^{40}. Table 4.5-8 presents the natural radioactive decay calculated from K^{40}-derived beta activity as a percentage of the gross beta measured in the surface water samples. It is apparent that most, if not all, beta radiation can be attributed to the naturally occurring radioisotope K^{40} in the Portneuf River water.

Radium-226 was detected in one sampling round at stations SW25, SW24, SW19, SW12E, and SW01 and in two sampling rounds at stations SW17 and SW03. Radium-228 was detected at least once in all upstream river stations except SW22 and was detected in three rounds of sampling at SW23, SW21, and SW20. Radium-228 was detected during one round of sampling at the downstream stations SW12E, SW12, SW07, and SW01. Results for both radium-226 and radium-228 indicate only moderate variations, with no clear distinctions between losing-reach and gaining-reach stations.

Samples from stations SW25, SW24, SW22, SW17, SW10, and SW1 were analyzed for uranium isotopes during the February 1993 round of sampling only. Uranium-233/234 was detected at comparable activities (1.12 ± 0.47 to 1.40 ± 0.35 ρCi/l) in all six samples. Uranium-235 and uranium-238 were not detected.

4.5.2 NATURE AND EXTENT OF EMF-RELATED CONSTITUENTS IN SEDIMENTS

The nature and extent of EMF-related constituents in sediments were investigated using statistical comparisons of constituent concentrations in different sample groups, cluster analysis, and direct comparison of sediment chemical concentrations to representative soil concentrations. The results of these comparisons and analyses were used to draw conclusions as to the nature and extent of EMF effects on river and spring sediments. The highest degree of confidence was placed on the statistical analyses. The comparison of sediment concentrations with soil concentrations is a more qualitative comparison because sediment chemistry is not directly comparable to surface soil chemistry.

In two locations, SD11 and SD9, silt and clay-rich sediments were collected in a spring pools with very low current velocities. These two locations are within the area of surface soils that have been influenced by EMF emissions. The EMF effects resulting from surface runoff pathways and aerial deposition pathway, if significant, would likely have been reflected in these sediment samples.

4.5.2.1 Sediment Chemistry Data – Overall Results

The only sediment sample that directly reflected a release from the EMF facilities was SD17, collected at the IWW ditch outfall. The investigation in the area of the outfall demonstrated a very localized effect. Statistically significant elevated chemical concentrations were not encountered at sample locations further downstream.

Cadmium, chromium, vanadium, zinc, fluoride, and total phosphorus were detected in sediment sample SD17 at concentrations in excess of the upstream sediment concentrations and representative soil concentrations (Tables 4.5-9 and 4.5-10; Figures 4.5-18 and 4.5-19). Sediment samples collected downstream from SD17 in the river channel and spring drainages did not contain elevated concentrations of cadmium, chromium, vanadium, zinc, or fluoride, and one downstream sample, SD10, had higher total phosphorus than SD17 (Tables 4.5-11 and 4.5-12; Figures 4.5-20 and 4.5-21).

Sample SD10 contained 7,150 mg/kg total phosphorus, the highest of any sediment sample. This sample was collected from the river channel where it is joined by the Batiste Spring drainage. The next highest concentration of total phosphorus was found at the IWW ditch outfall (5,340 mg/kg). Concentrations above the upstream sediment and representative soil levels were observed in the Fort Hall Bottoms (SDC1 at 1,160 mg/kg and SDC4 at 1,060 mg/kg).

Arsenic values exceeded upstream sediment and soil representative levels at stations SD18 (8.4 mg/kg) and SD8 (9.9 mg/kg). Spring sediment samples that exceeded the upstream sediment and representative soil level for arsenic were samples SD4 at Siphon Road Spring (8.2 mg/kg), SD7 at Papoose Spring (9.1 mg/kg) and SD2 at Twenty Spring-East (13.8 mg/kg). The Papoose Spring sample was taken in a ponded water area with very low energy, and the sample from Twenty Springs was taken in a low-energy swampy area. Like the river sediments, neither of these stations contained the suite of metals, fluoride, and total phosphorus associated with the EMF facilities. Therefore, the constituents found in these sediments are not reflective of EMF effects.

The highest levels of lead were detected in upstream sampling locations SD23 and SD24 (71.9 mg/kg and 51.6 mg/kg) respectively (Figure 4.5-22). Given the upstream locations of these samples relative to the EMF facilities, it is clear the lead is not related to the EMF facilities. The next highest lead concentrations in river sediment were found at locations SD19 and SD20. In general, lead concentrations were higher in upstream samples than in downstream samples. Figure 4.5-23 displays the lead values detected in the spring sediments. The discharge point of the Papoose System contained the highest level of lead detected in spring sediment (50.5 mg/kg).

Mercury was detected in one upstream location, SDA1, at a concentration of 0.55 mg/kg and one downstream location, SDB1, at a concentration of 1.1 mg/kg (Figure 4.5-22). The occurrence of mercury in the river sediments does not appear to be related to any identified specific source along the river and may, in fact, be naturally occurring (Appendix Q.)

Gross alpha activities appear to be related to soil textures, with sediments rich in clay or gravel being generally higher than those containing silt or sand. Sample location or proximity to the EMF site does not appear to be a factor. The one exception was at the IWW ditch outfall, which had the highest level of gross alpha activity (29.2 ± 3.6 ρCi/g).

Gross beta activities were positively correlated with potassium-40 content, with some exceptions. Gross beta activities were less than representative soil levels.

4.5.2.2 Sediment Statistical Comparisons

Sediment samples were compared statistically using several different methods: t-tests, non-parametric ANOVA (analysis of variance), and cluster analysis. The student's t-test uses the reported concentrations of chemicals and allows for a one variable (chemical) comparison between two groups of samples. It assumes a normal distribution. The objective in performing a student's t-test was to investigate differences between results for statistical significance. The non-parametric ANOVA is a test that is independent of the population distribution and the presence of nondetects in the dataset. The non-parametric ANOVA highlights differences that may be present, although masked by nondetects or other "noise" in the dataset. The cluster analysis compares sediment samples using numerous analytes concurrently, whereas the t-tests and ANOVA can only be applied to one analyte at a time.

Student's t-test. Sediment samples were assigned to spring, upstream, near-site, and downstream groups for statistical comparisons (Table 4.5-13). The spring and near-site samples were placed into separate groups to ensure that any influences from the EMF site would be identified in the statistical tests. Samples in the spring group are SD2, SD4, SD5, SD6, SD7, SD9, SD11, SD13, SD14, and SD15. Samples in the near-site group most likely to reflect the cumulative effects of IWW ditch outfall, surface runoff, and direct aerial deposition to the river are SD16, SD18, SD19, and SD20. Samples SD21, SD22, SD23, SD24, SD25, SDA1, and SDA2 form the upstream group, which is least likely to be affected by EMF-related activities. The downstream sediment sample group includes SD12, SD10, SD8, SD3, SD1, SDB1, SDC1, SDC2, and SDC4. Sample SD17 was not included in any group because it reflected EMF-related influences.

The test hypothesis was that the sediment sample groups were collected from the same sediment population. The hypothesis was tested at the 95% confidence level. Where the absolute value of the calculated t-value was greater than the corresponding 95% confidence interval t-value from the statistical table, the hypothesis would be rejected. Rejection of the hypothesis would indicate that the two sample groups were not collected from the same population, and that there is a statistically significant difference between their mean concentrations.

Results of the t-tests show that sample means for near-site sediments are not statistically different from upstream sediment means for any constituents, except iron (Table 4.5-13). Iron is the only constituent for which there was a statistically significant difference between the sample means of the two sediment groups, with upstream sediments having a higher iron content.

When spring sediments were compared with the upstream sediments, the upstream sediments had higher mean concentrations of aluminum, copper, lithium, manganese, and nickel. Spring sediments were higher in beryllium, which is likely a result of the elevated beryllium concentrations in samples SD9 (FMC Employee Park) and SD2 (Twenty Springs East).

Upstream sediments had statistically higher concentrations of cobalt, manganese and vanadium at the 95% confidence level, compared with spring sediments. This result is particularly important for vanadium given that it is a characteristic constituent of EMF potential source materials (e.g., ore and precipitator dust).

There was no statistically significant difference in total phosphorus content between upstream and downstream sediment even though the mean total phosphorus concentration in the downstream sediment sample group was 1,463 mg/kg compared with a mean in the upstream sediments of 357 mg/kg. This indicates that, although there was a higher concentration of total phosphorus at SD10, the overall total phosphorus content of downstream sediments is not statistically different from the upstream sediments.

Non-Parametric ANOVA. A non-parametric test, instead of a t-test, was used to evaluate selenium, mercury, thallium, and cadmium because these datasets contained a high proportion of nondetects. The nonparametric ANOVA or Kruskal-Wallis tests whether any of the sediment sample groups are from a different population. This is tested at the 95% confidence level. The same sediment groups used in the t-test analyses were used in the ANOVA analysis. The test results indicate no differences between sediment sample groups for mercury, selenium, thallium, or cadmium (Table 4.5-13).

Molybdenum was detected in only one upstream sample, and antimony was not detected in any sediment sample. Therefore, neither of these parameters were tested for significance using either the t-test or non-parametric ANOVA.

Cluster Analysis. A cluster analysis was performed on the sediment data for manganese, aluminum, iron, total phosphorus, fluoride, zinc, barium, arsenic, gross beta, lead, cadmium, chromium, copper, vanadium, and selenium. These analytes were selected because these analytes best encompassed the overall dissimilarities in the sediment composition. Note that the six characteristic constituents are included in this grouping. Other metal and radiological constituents (e.g., Ni, Li) correlated well with one or more of the constituents used in the cluster analysis, and would only have served to reduce the "dissimilarity" between samples had they been included.

The results indicate that SD17 (Phase I IWW outfall) and SD17A (Phase II IWW outfall) are very dissimilar to other samples, and are not very similar to one another. SDB1A, collected from a public boat launch area, is also very distinct from other samples. According to the cluster analysis, it is most similar to SDA1, which was collected several thousand feet upstream from the EMF site. If SDA1 does not reflect any EMF-related impacts (which is likely since there is no pathway between the site and SDA1), then it follows that the chemistry of sample SDB1A does not necessarily reflect EMF-related influences. Why these two samples are different from the others cannot be explained with the available data.

Sample SD10, which contained the highest total phosphorus concentration, is most similar to SD13, the sediment sample collected at the STP spring pond. If SD10 were indicative of EMF-related impacts to the river, SD10 might have been expected to be more similar to SD14, SD17, SD17A, or SD15, because these samples were collected in the immediate vicinity of EMF-related discharges.

Upstream sediments are not similar to each other and show the same degree of similarity to downstream and spring sediments. Because upstream sediments, downstream sediments, and spring sediments do not show distinct groups that are spatially related to EMF discharges or transport pathways, the cluster analysis demonstrated that there is no distinct EMF fingerprint in the sediments.

4.5.2.3 River Sediments – Detailed Discussion

A detailed discussion of the chemical characteristics of river sediments upstream of all EMF-related discharges to the Portneuf River is presented below. This characterization of upstream sediments provides a basis for evaluating the analytical results for sediment samples collected in areas that might have been influenced by pathways that transport EMF-derived constituents to surface water sediments. This characterization of upstream sediments is followed by a sample-by-sample discussion of sediment samples collected in the Portneuf River channel. Conclusions regarding EMF-related influences are based on the results of the statistical tests (Section 4.5.2.2), comparisons with upstream sediment concentrations and soil representative levels, the presence of characteristic EMF parameters, and the presence of a pathway between the EMF facilities and the river sediment and depositional environment. A sample-by-sample discussion of the spring sediment samples is presented in Section 4.5.2.4.

Upstream Sediments (SD25 to SD21, SDA1 and SDA2). Upstream sediment samples exceeded the soil representative levels for aluminum (SDA1), boron (SDA1), copper (SDA1 and SD23), lead (SD24 and SD23), manganese (SD25), mercury (SDA1), molybdenum (SD21), and zinc (SDA1) (Table 4.5-9). The upstream sediments did not contain orthophosphate or total phosphorus at concentrations in excess of the representative levels. Fluoride exceeded its representative level of 600 mg/kg in SD23 (1,300 mg/kg). Despite these differences, it appears that the upstream sediments were generally similar in chemical composition to local soils.

Slightly higher zinc, copper, mercury, and lead concentrations may be due to discharges to the river from potential sources within Pocatello or further upstream. Alternatively, the higher concentrations may be indicative of natural variability within the river system. Regardless, the upstream sediment metal concentrations were similar to soil representative levels.

Sample SD20. Location SD20 is approximately 1,800 feet downstream from SD21 (Figure 4.5-1f). The texture of sample SD20 was a sand with silt and gravel. Lead (61.0 mg/kg) and silver (3.0 mg/kg) exceeded representative levels. All other constituents were within soil representative levels, including the EMF characteristic metals. This location was not impacted by EMF operations.

A comparison of the results found at this location with the upstream samples indicates similar, but generally lower concentrations of metals and nutrients (Tables 4.5-9 and 4.5-10). This result is expected since the sample was a sand rather than a clay, and less likely to contain naturally occurring trace metals in its matrix or to contain adsorbed metals.

Sample SD19. Location SD19 is approximately 1,000 feet downstream from SD20 (Figure 4.5-1f). The texture of this sample was a silty clay. Lead (38.6 mg/kg) and copper (12.7 mg/kg) concentrations exceeded soil representative levels. Higher lead, copper, and fluoride concentrations were detected in other samples further upstream, so their occurrence here does not indicate an EMF-related impact. This sample does not appear to be indicative of EMF facility impact.

Sample SD18. Location SD18 is near the old FMC and Simplot outfalls. It is approximately 350 feet downstream from SD19. The texture of the sediment was sand with gravel. Arsenic was detected at 8.4 mg/kg, above the representative soil level of 7.7 mg/kg. Thallium was detected at a concentration of 0.30 mg/kg compared with a representative level of 0.27 mg/kg. The remaining constituents were below both representative and upstream trace metal levels (Table 4.5-9). The arsenic concentration is likely within the variability of representative levels in the river sediments. Because the reported thallium value was an estimated value (i.e., J qualifier) that is very close to the representative level for soils, thallium was not considered elevated.

Sample SD17. Sample location SD17 is located several feet beyond and downstream of the current FMC outfall. Its texture was a sandy clay. When dried, the material contained a gray, clay-like material with shell and rock fragments. The sand fraction was coarse, pink and purple sand. Also, the sample contained considerable organic matter in addition to the mineral matrix. This sample contained a number of constituents above representative soil levels, including the suite of constituents characteristic of potential sources at FMC (Tables 4.5-9 and 4.5-10). Therefore, the sample is considered to have been influenced by FMC industrial activities. A petrographic thin section of the sample was made and compared with thin sections of slag, phosphate ore, and precipitator slurry. The visual microscopic comparison indicated that the sediment sample contained components of precipitator dust and ore. The presence of ore is not surprising since the IWW ditch runs just to the east of the FMC ore pile. The thin section evaluation report is presented in Appendix I.

During Phase II sampling in July 1993, three additional samples were gathered in the vicinity of the FMC outfall (Figure 4.5-1h). Sample SD17A was collected from the river channel directly in front of the FMC outfall pipe. FMC had placed a steel plate in front of the pipe to act as a baffle, and the sample was taken behind it. Sampling in front of the pipe was not possible because there was very little space between the plate and the outfall pipe, and the river bottom area had been thoroughly scoured. The texture of the sample taken from this area was a sandy gravel. It contained above-representative levels of various parameters including the suite of FMC characteristic constituents (Table 4.5-14). Sample SD17B was taken downstream on the eastern side of the river (the main channel is along the west side of the river). Its texture was a fine sand with some shell fragments. Sample SD17C was taken on the east border of the river approximately 70 feet (22 m) downstream from the outfall pipe. Its texture was moderate to fine sand with shell fragments. All parameters for samples SD17B and SD17C, with the exception of calcium (102,000 mg/kg and 208,000 mg/kg, respectively), were below representative soil levels, and contained no evidence of the EMF characteristic constituents. The high calcium level were probably due to the dissolution of the shells during sample preparation.

The sampling carried out in the area of the FMC outfall indicates a very localized impact on river sediments around the outfall. Samples collected in the downstream portion of this area and at points further downstream did not contain the EMF characteristic constituents above representative levels and, hence, indicate that there has been no measurable impact beyond the outfall.

Sample SD16. Location SD16 is located north of Batiste Road. The sediment sample was taken on the eastern side of the river. Its texture was silty clay. Copper (30.8 mg/kg), thallium (0.73 mg/kg), and zinc (56.9 mg/kg) were detected in the sample at above representative soil values (Table 4.5-9). The remaining parameters were below representative soil concentrations and upstream sediment concentrations. The absence of high cadmium, chromium, and vanadium, and the low values of fluoride (273 mg/kg) and total phosphorus (554 mg/kg) indicate that the sediments were not impacted by the EMF facilities.

Sample SD12. Location SD12 is located 80 feet (24 m) downstream from the STP discharge. Sediments were collected on the west side of the channel. The sediment texture was sand. Beryllium (1.1 mg/kg) and silver (2.2 mg/kg) exceeded representative soil concentrations. All other parameters were within both the representative soil range and upstream sediment sample values (Tables 4.5-9 and 4.5-10). It should be noted that, given the geometry of the river at this location, SD12 is probably not an area where deposition from the STP discharge would occur.

Sample SD10. Sample SD10 was collected within the river just downstream from the mouth of Batiste Spring. The texture of the sample taken here was fine sand. Metals, orthophosphate, and fluoride concentrations were below the representative soil concentrations and upstream sediment concentrations (Tables 4.5-9 and 4.5-10). The only constituent above its representative level was total phosphorus, which had a value of 7,150 mg/kg. As illustrated by the statistical test, total phosphorus concentrations in downstream sediments were not significantly higher. The cluster analysis indicated that sediments at SD10 were most similar to those at the STP Spring (SD13).

Sample SD8. Location SD8 is near the mouth of the spring-fed pond at the FMC park (Figure 4.5-1d). The texture of the sample contained considerably more silt and clay than sand. Arsenic was detected in this sample at a concentration of 9.9 mg/kg, compared to a representative soil concentration of 7.7 mg/kg (Table 4.5-9). Although this arsenic concentration may reflect an anthropogenic impact to the Portneuf River, other EMF-related constituents did not exceed representative concentrations.

Sample SD3. Sediment sampled at location SD3 was taken in the river at the bridge at Siphon Road (Figure 4.5-1b). Its texture was loam with sand and gravel. The relatively low aluminum value (3,670 mg/kg) suggests that the portion of the sample tested in the laboratory was more sandy than silt/clay. None of the analytical parameters exceeded representative soil concentrations; all concentrations were below the values found in the upstream samples (Tables 4.5-9 and 4.5-10).

Sample SD1. Sediment sample SD1 had a texture described as loam (e.g., approximately equal portions of sand, silt, and clay). The only parameters that exceeded representative soil concentrations were silver and thallium. Silver was detected at a concentration of 2.1 mg/kg compared with a representative level of 1.9 mg/kg, and thallium was detected a concentration of 0.28 mg/kg compared with a representative level of 0.27 mg/kg. The remaining parameters were within representative levels and generally below those values found in the upstream samples.

Sample SDB1. Location SDB1 sediment was collected at a public boat launching area in the Fort Hall Bottoms and above the high water mark of the American Falls Reservoir (Figure 4.5-1i). Its texture was silty clay. This sample contained numerous parameters above representative soil levels although not generally above values found in the samples upstream of the EMF facilities (Tables 4.5-9 and 4.5-10). Also, not all of the EMF characteristic constituents were present. The lack of elevated levels of vanadium, cadmium, total phosphorus, and fluoride indicates the absence of EMF facilities-related particulates (Tables 4.5-9 and 4.5-10). The presence of trace metals, such as lead (30.9 mg/kg), copper (25.5 mg/kg), mercury (1.1 mg/kg), and zinc (97.1 mg/kg), at above-representative levels may be attributed to high clay content. Other constituents above representative levels were aluminum (16,200 mg/kg), iron (16,100 mg/kg), and total organic carbon (11,074 mg/kg). Aluminum and iron concentrations reflect the high clay content of this sediment. This content, combined with the high organic content, imply a potential for a high metal adsorption/absorption capacity of the soil matrix. Furthermore, the Fort Hall Gravels which outcrop in this area contain native elemental and mineral-phase mercury.

Sample SDC1. Sediment sample SDC1 was taken on the downstream side of a point bar. Its texture was silt with fine sands (Figure 4.5-1i). With the exception of calcium (166,000 mg/kg) and total phosphorus (1,160 mg/kg), all parameters were below representative levels and, in general, below upstream sample levels (Tables 4.5-9 and 4.5-10).

Sample SDC2. River sediment was sampled at location SDC2, approximately 1,000 yards downstream from SDC1 (Figure 4.5-1i). Its texture was silty clay. With the exception of calcium (88,500 mg/kg), all parameters were below representative soil levels (Tables 4.5-9 and 4.5-10).

Sample SDC4. Sediment sample SDC4 was taken approximately 400 feet downstream from SDC2 (Figure 4.5-1i). Its texture was a clayey silt. Boron and copper were slightly above representative soil levels. Boron was reported at 13.1 mg/kg compared with a representative level of 12.8 mg/kg, and copper was detected at 12.9 mg/kg compared with a representative level of 12.6 mg/kg. Calcium (93,200 mg/kg) and total phosphorus (1,060 mg/kg) were also detected above representative soil levels. Total organic carbon was detected at 9,468 mg/kg.

Radiological Parameters

Gross alpha and gross beta were measured on all sediment samples taken during the investigation. All measurements were below their corresponding soil representative levels.

Gross alpha values ranged from 6.33 ± 2.96 ρCi/g (SDA2) to 13.6 ± 1.28 ρCi/g (SD23) in the upstream samples (Tables 4.5-15 and 4.5-16). The highest gross alpha activity (29.2 ± 3.6 ρCi/g) was found at location SD17, the FMC outfall. This observation is expected since the FMC potential sources (Section 4.2.3) contain alpha emitters. The elevated gross alpha at SD17 corroborates previously discussed evidence of EMF impact at this location.

With the exception of SD17, sediment samples from SD21 to SDC4 all contained 12 ρCi/g or less gross alpha, which is less than the high end of the range of the activities detected in upstream samples. Even SDB1, which contained several metals at elevated concentrations, but not those characteristic of EMF potential sources, has a relatively low activity (8.15 ± 3.33 ρCi/g). This observation lends additional support to the conclusion that above-representative inorganic parameters found in SDB1 were not related to the EMF facilities.

In summary, the EMF-related discharge responsible for the gross alpha values observed at SD17 does not appear to have impacted sediments further downstream. In addition, the lack of elevated gross alpha activities in river sediments at locations other than SD17 suggest that impacted offsite surface soils have not migrated to the river as surface runoff. The gross alpha results support conclusions drawn from results for the EMF characteristic constituents.

In examining gross beta values, it should be noted that potassium-40 may be a major contributor to these values. Potassium is generally a major component of natural clay soils and, as has been described previously, it is a major component of several EMF potential sources. However, the gross beta and potassium-40 sediment values (Tables 4.5-15 and 4.5-16) were not always well correlated, indicating another unidentified beta-emitting source. However, all gross beta values, including SD17, were below the representative soil value.

Upstream gross beta activities ranged from 10.2 ± 2.62 ρCi/g (SDA1) to 25.3 ± 1.45 ρCi/g (SD24). These values reflect the silty/clayey nature of the sediments. The highest activity detected among all the samples was at SD17, where 30 ± 3.15 ρCi/g gross beta was detected. This observation is not unexpected since this sediment sample contains EMF-related particulates. Sediment samples collected downstream of SD22, excepting SD17, had gross beta values ranging from nondetect at 5 ρCi/g to 16.9 ± 2.35 at SD19. These values support the conclusion that EMF-related impacts are confined to location SD17.

4.5.2.4 Spring Sediments – Detailed Discussion

A sample-by-sample presentation of the spring sediment sampling results is provided in this section. Constituents that exceeded representative soil concentrations are highlighted and discussed. The spring sediments are also compared with the sediments collected from the upstream reach of the Portneuf River. Conclusions regarding EMF-related influences are based on the results of the statistical tests (Section 4.5.2.2), comparisons with representative levels, the presence of characteristic parameters, and the presence of a pathway between the EMF site and the spring.

Sample SD15. Location SD15 is at Swanson Road Spring (Figure 4.5-1e). The sediment texture was a sand with silt. The silver concentration (2.1 mg/kg) exceeded the representative soil level. Other metals were below representative levels. The total phosphorus concentration was 955 mg/kg, above the representative value of 672 mg/kg. Orthophosphate (4.9 mg/kg) and fluoride (333 mg/kg) were below the representative soil levels.

Samples SD11 and SD14. Sediment samples SD14 and SD11 were collected from Batiste Spring and the spring drainage channel (Figure 4.5-1e). The texture of sample SD14 was sand and gravel. The texture of sample SD11 was clayey sandy gravel sample. Sample SD14 contained above-representative concentrations of copper (13.0 mg/kg), lead (29.5 mg/kg), and barium (324 mg/kg). Sample SD11 contained only one constituent, zinc, at an above-representative value (107 mg/kg). As discussed above, the upstream sediments in the river also had lead and copper concentrations in excess of representative soil levels. This appears to be true of the spring sediments as well. The barium content in Batiste Spring sediments may reflect a localized site-related impact.

The sample from SD11 was not collected in the main Batiste channel, but rather in a low-energy pool that is within the area where aerial deposition of EMF-related materials might be expected to have occurred (offsite soil samples SS45-1C and SS023-1C, Table 4.3-3). As discussed in Section 4.3, surface soil samples (north of the EMF facilities) contained the suite of EMF characteristic constituents. However, sediment sample SD11 did not. Since the characteristic constituents were not evident in the sediment, neither air deposition nor overland runoff appear to have had measurable impacts on sediment, even in an area of quiescent surface water. The quiescence of this surface water body is substantiated by the occurrence of clay in the sediments. Deposition of clays on freshwater substrates requires extremely low current velocities in the overlying water column. If significant quantities of EMF materials were transported via the air pathway to surface water and sediments, the particulates would likely be clay size or smaller (less than 1/256 mm), and extremely low current velocity would be necessary for these particulates to collect in sediments.

Sample SD13. Sample SD13 was collected between the Portneuf River and the Pocatello STP sludge-drying beds (Figure 4.5-1e). The spring, located on STP property, has a fairly large spring pond with sandy sediment as the substrate. The texture of sample SD13 was sand. The sample (Tables 4.5-11 and 4.5-12) contained above-representative levels of total phosphorus (3,950 mg/kg), fluoride (800 mg/kg), and selenium (3.5 mg/kg). The most probable source for the elevated constituents is the STP sludge drying beds. As described in Section 4.4, the springs along the eastern side of the river do not discharge any groundwater impacted by EMF-related activities, thus eliminating the possibility that selenium, total phosphorus, or fluoride in the sediment sample is from the EMF site.

Sample SD9. Sediment sample SD9 was taken at the spring-fed pond at the FMC park (Figure 4.5-1d). Its texture was a loam. This spring is fed by the Portneuf River Valley hydrogeochemical regime and is uninfluenced by EMF facilities-related groundwater because the spring is located on east side of the river. Beryllium (1.40 mg/kg) was above the representative soil level of 1.0 mg/kg. As was true with SD11, this very quiet pond is also within the influence of potential air deposition from the EMF facilities, as shown by impacted offsite soil sample 000-2A (Table 4.3-3), and as was true at SD11, there was no measurable evidence of an EMF-related impact in the sediment. This observation further supports the conclusion that neither air deposition nor overland runoff is a pathway for sediment impact.

Samples SD5 and SD7. Sampling stations SD7 and SD5 are located in the Papoose Spring System (Figure 4.5-1c). Neither spring is downgradient of sources impacting groundwater within the EMF facilities. Sediment sampled at location SD7 was taken in the northeastern portion of the pond fed by Papoose Spring. Its texture was clayey, sandy gravel. Sediment sample SD5 was taken at the mouth of the spring reach as it entered the Portneuf River. Its texture was silty clay. There was an operating fish farm between the two sampling points at the time of sampling. The only parameter with an above-representative concentration in SD7 was arsenic at 9.1 mg/kg. The arsenic representative level for soils is 7.7 mg/kg. The sample collected at station SD5 contained above-representative soil levels of lead (50.5 mg/kg), thallium (0.30 mg/kg), and zinc (54.3 mg/kg). (Soil representative levels are 29.1 mg/kg for lead, 52.8 mg/kg for zinc, and 0.27 mg/kg for thallium.) As noted before, the lead in sediments throughout the Portneuf River exceeded representative levels at upstream locations, indicating lead is enriched by non-EMF sources in the river sediments relative to soils.

Sample SD4. Sample SD4 was taken at a spring near Siphon Road (Figure 4.5-1b). Its texture was loam. Sample SD4 contained 8.2 mg/kg arsenic, which is greater than the soil representative level of 7.7 mg/kg. The remaining parameters detected in this sample were below representative soil concentrations. There is no groundwater pathway for arsenic transport from the EMF site to the sediments in this spring, making the EMF site an unlikely source of the arsenic detected in this sample.

Sample SD2. Sample SD2 was taken on the eastern branch of Twenty Spring (Figure 4.5-1a). The sediment was silty clay. The area in which it was taken was very swampy. In addition, the recovery for the sample was poor insofar as it was reported to consist of only 20 percent solids. Samples with low percent solids content are difficult to quantitate on a dry weight basis, and the results from such quantitation are generally biased high. Hence, while elements reported as detected in the sample were probably present, their reported values were likely overestimates of the true concentrations. Four constituents were reported at concentrations above representative soil levels. These constituents were arsenic (13.8 mg/kg), beryllium (2.2 mg/kg), chromium (54 mg/kg), and vanadium (192 mg/kg). Zinc, generally found in much greater abundance than vanadium in EMF-related materials, was below the representative soil level at 37.4 mg/kg. Fluoride was detected at 75.3 mg/kg, and total phosphorus was detected at 64.5 mg/kg. These two constituents are considered primary indicators of EMF-related impacts; however, the concentrations of these two constituents in sample SD2 are very low compared to other sediment samples. While the four parameters that exceeded representative levels can be found in EMF potential source-related matrices, the levels of other parameters that have a stronger association with EMF materials suggest that this sample had not been affected by EMF-related activities.

Radiological Parameters

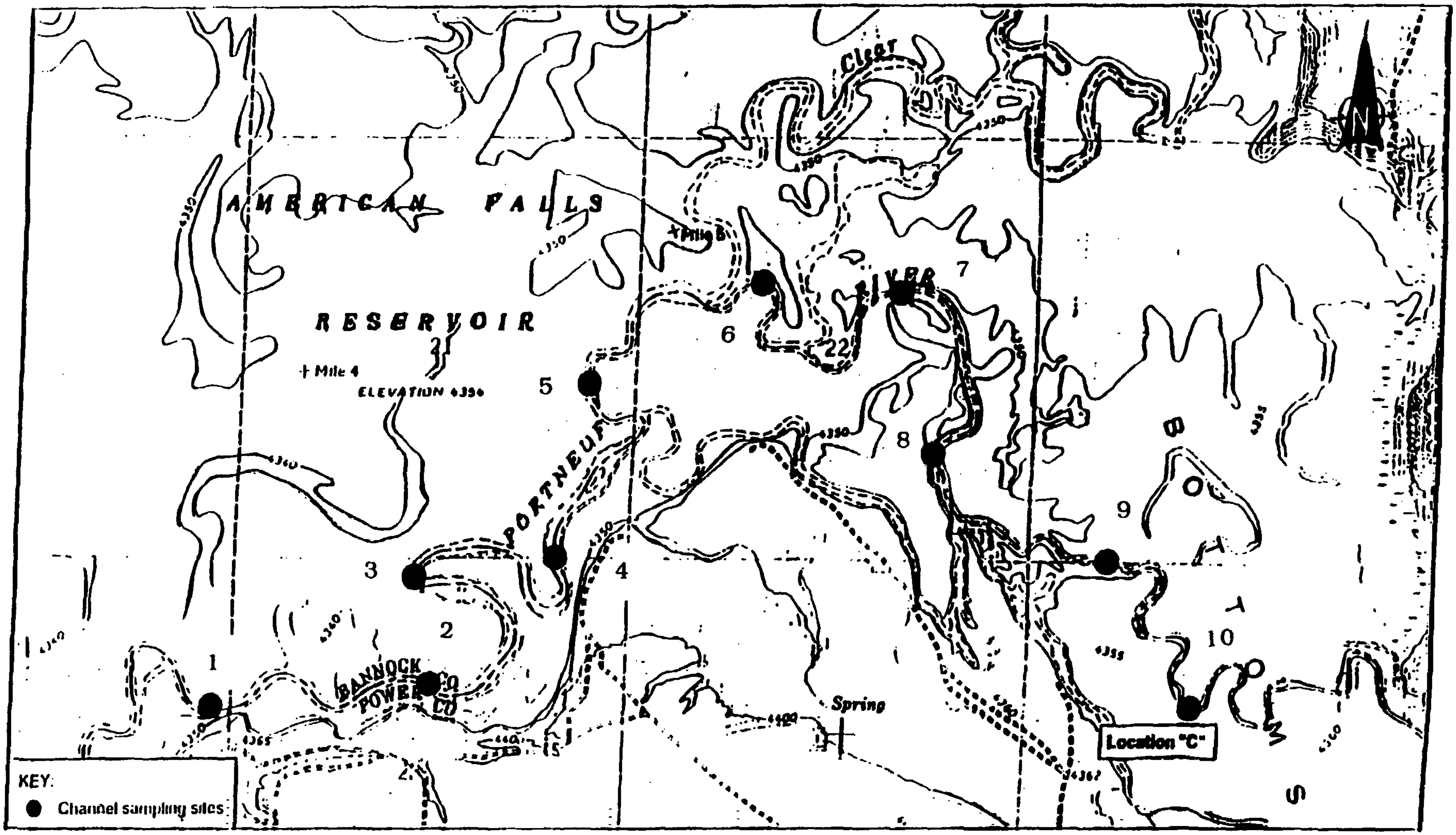
Spring sediments, in general, had higher levels of gross alpha than the river sediments (Table 4.5-16). However, the gross alpha activities in all spring sediments were less than the representative soil level (24.7 ρCi/g). There was no correlation of gross alpha activity with location. The highest value (19.8 ± 2.49 ρCi/g) was detected at SD14 (Batiste Spring), which is fed by Bannock Range water that is impacted by EMF activities. However, a similar value (14.8 ± 1.35 ρCi/g) was detected at SD13, located on the east side of the river and fed by the Portneuf River Valley hydrogeochemical regime, uninfluenced by the EMF facilities. The sediments found in the springs and spring drainage channels are locally derived and have somewhat higher gross alpha activity than the upstream sediment sources.

The same pattern exists for gross beta as exists for gross alpha. The highest gross beta activities were found in the more clay-rich sediments (SD2, SD5, and SD9 at 19.7 ± 2.1, 18.2 ± 2.3, and 19.5 ± 2.1 ρCi/g, respectively). The gross beta representative soil level is 31.4 ρCi/g.

TABLE 2.4-1
SURFACE WATER AND SEDIMENT INVESTIGATION
SAMPLING SUMMARY (1992 - 1993)

Location	Sampling Date				Flow Rate Measured				Location Description
	1992		1993		07/92	10/92	02/93	04/93	
OFFSW01	28-Jul	28-Oct	4-Feb	1-May	Yes	Yes	Yes	Yes	River Mile 10
OFFSW02	28-Jul	28-Oct	5-Feb	1-May					Eastern Springs
OFFSW03	28-Jul	28-Oct	4-Feb	30-Apr	Yes	Yes	Yes	Yes	River at Siphon Road
OFFSW04	28-Jul	28-Oct	5-Feb	30-Apr					Springs at Siphon Road
OFFSW05	29-Jul	29-Oct	4-Feb	30-Apr					River at Fish Farm
OFFSW05E				30-Apr					Channel at Fish Farm - West Fork
OFFSW05F				30-Apr					Channel at Fish Farm - East Fork
OFFSW06	29-Jul	28-Oct	7-Feb	29-Apr					Pond at Fish Farm
OFFSW07	29-Jul	27-Oct	7-Feb	29-Apr					Springs at Fish Farm
OFFSW07E				29-Apr					River across from Fish Farm
OFFSW08	29-Jul	27-Oct	4-Feb	29-Apr					River at FMC Park
OFFSW09	29-Jul	28-Oct	2-Feb	29-Apr					Springs at FMC Park
OFFSW10	30-Jul	27-Oct	4-Feb	29-Apr	Yes	Yes	Yes	Yes	River at Batiste Springs discharge
OFFSW11	30-Jul	27-Oct	7-Feb	29-Apr					Batiste Springs at creamery
OFFSW12	30-Jul	27-Oct	4-Feb	29-Apr					River above STP discharge
OFFSW12E				29-Apr					River at STP discharge
OFFSW13	30-Jul	28-Oct	2-Feb	29-Apr					Springs near STP
OFFSW14	31-Jul	27-Oct	3-Feb	28-Apr					Batiste Springs
OFFSW15	31-Jul	26-Oct	2-Feb	28-Apr					Springs near Batiste Road
OFFSW16	31-Jul	26-Oct	3-Feb	28-Apr	Yes	Yes	Yes	Yes	River at Batiste Road
OFFSW17	31-Jul	26-Oct	3-Feb	28-Apr					River at FMC discharge
OFFSW18		26-Oct(a)							River at old FMC discharge
OFFSW19	1-Aug	26-Oct	6-Feb	28-Apr					River near gypsum stack
OFFSW20	1-Aug	5-Nov	6-Feb	27-Apr					River near gypsum stack
OFFSW21	1-Aug	26-Oct	6-Feb	27-Apr					River upstream of gypsum stack
OFFSW22	2-Aug	26-Oct	3-Feb	27-Apr					River Mile 15
OFFSW23	2-Aug	26-Oct	5-Feb	27-Apr					River downstream of RR sites
OFFSW24	2-Aug	26-Oct	2-Feb	27-Apr					River upstream of RR sites
OFFSW25	2-Aug	26-Oct	2-Feb	27-Apr	Yes	Yes	(b)	Yes	River upstream of Pocatello

Notes: (a) Sample not required for compliance with EMF RI/FS SAP.
(b) Measurement not possible because of river ice.



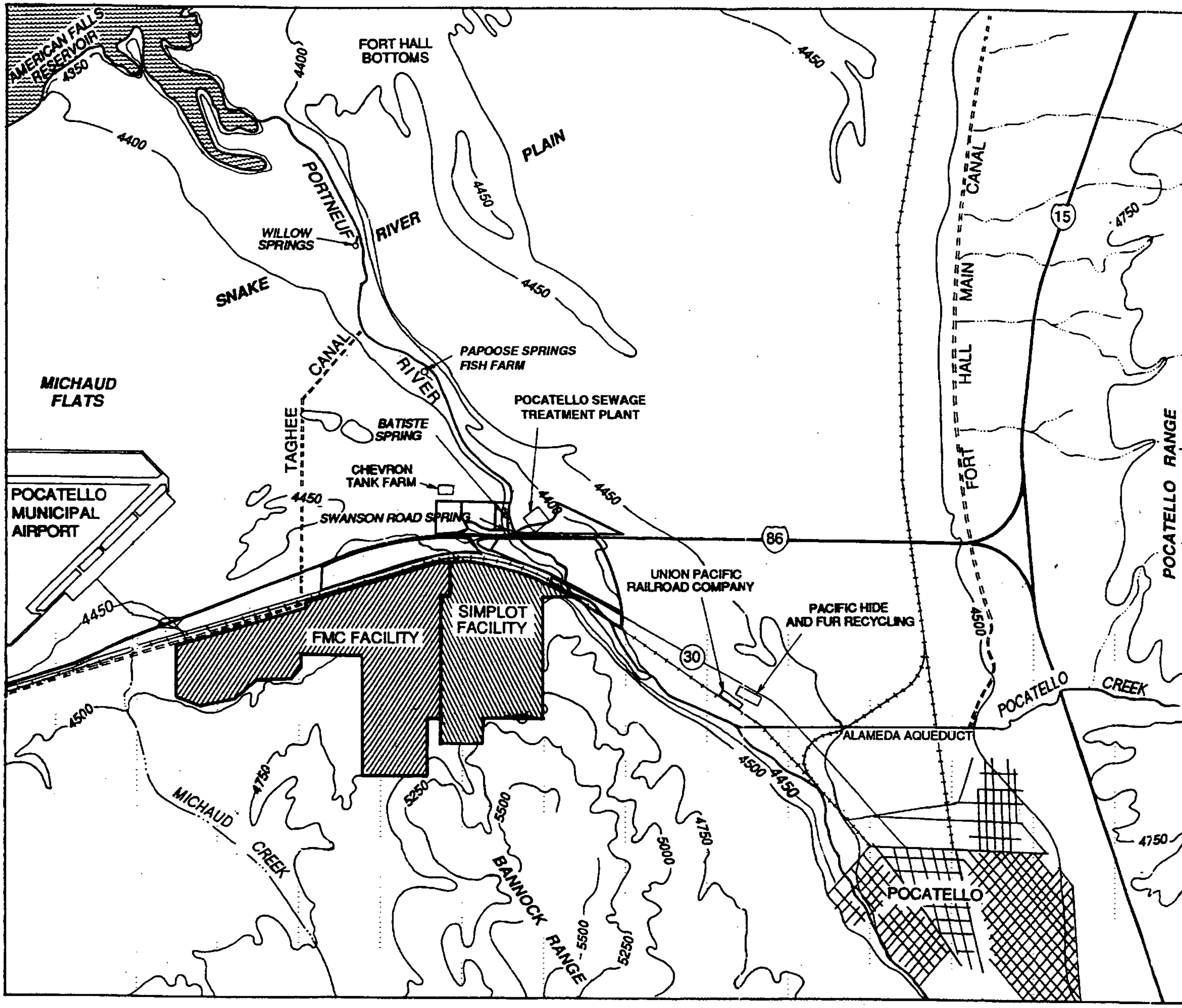
SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Michaud, ID 1971

SCALE 1:24,000

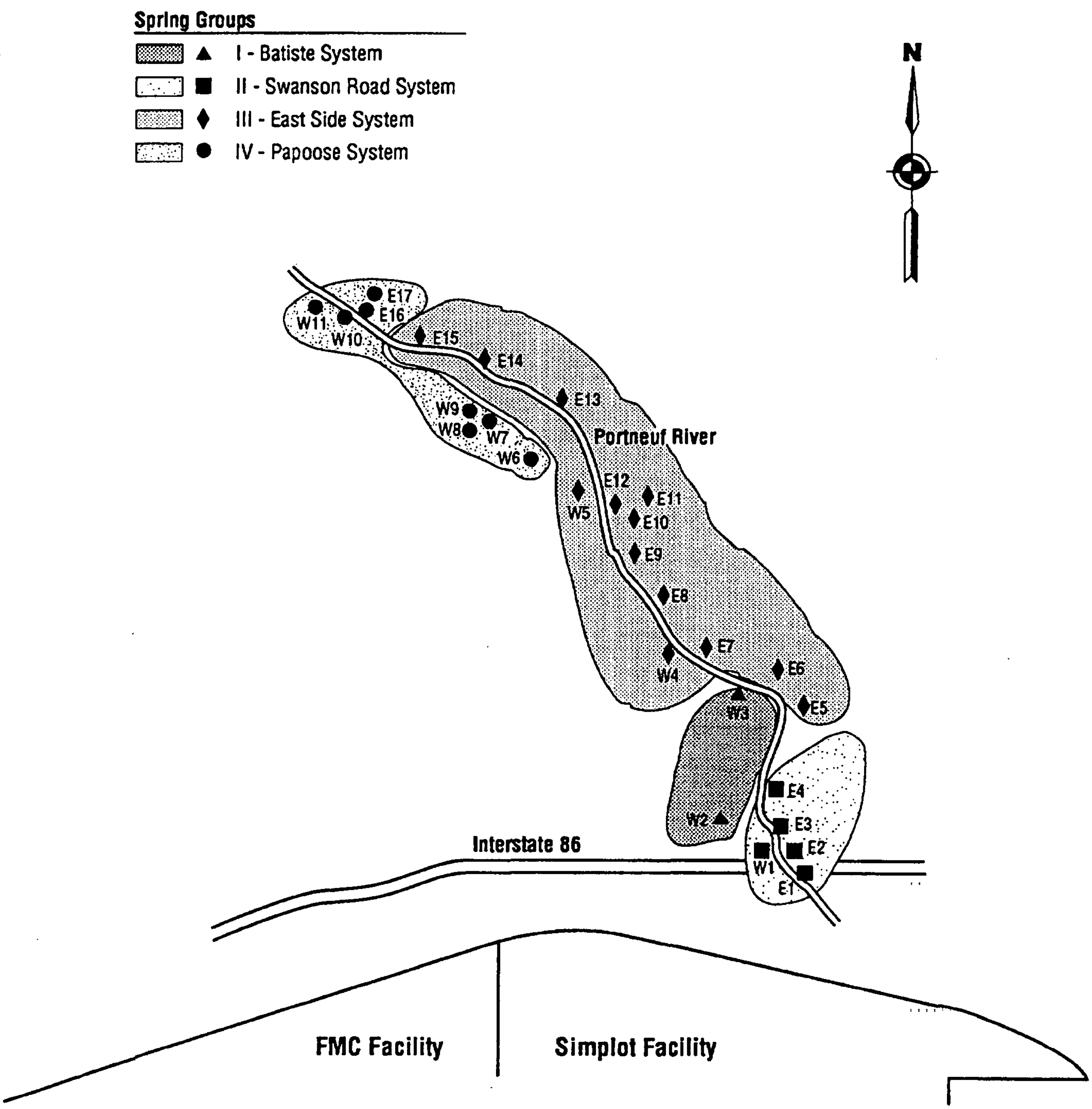
0 ½ 1 Mile

0 .5 1 Kilometer

Figure 2.7-2 PORTNEUF RIVER DELTA SAMPLING SITES



BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO		
EASTERN MICHAUD FLATS POCATELLO, IDAHO		
Regional Setting		
JOB No. 21372	DRAWING NO. FIGURE 1.3-1	REV.



Note:
Modification of map by Perry et al. (1990) showing location of springs, with the four "spring groups" defined with cluster analysis of water chemistry.

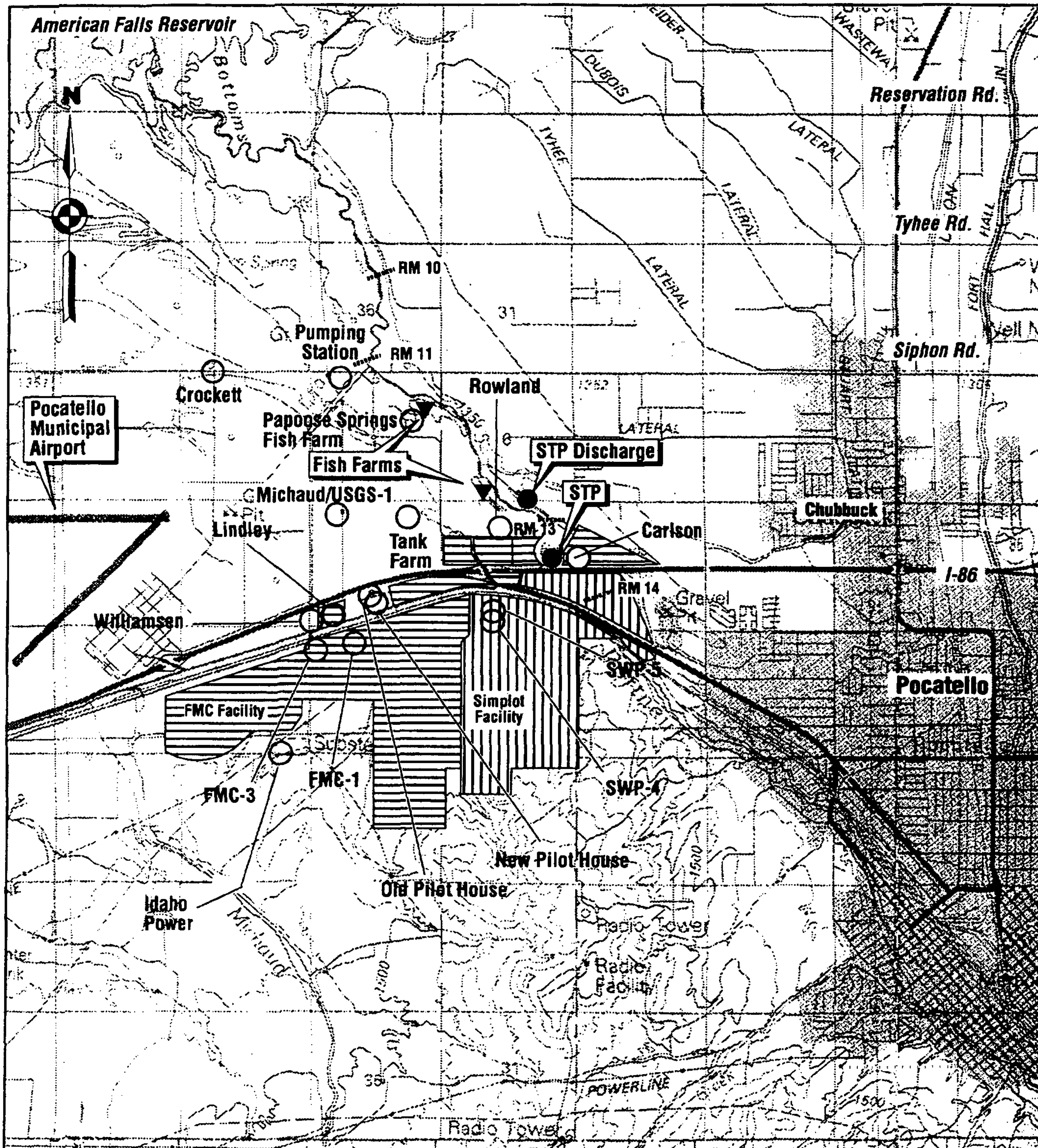
Scales

0 — 1 mile

0 — 1 — 2 kilometers

BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO		
EASTERN MICHAUD FLATS POCATELLO, IDAHO		
Location of Spring Groups on Portneuf River		
JOB No.	DRAWING NO.	REV.
21372	FIGURE 1.3-2	

93-1477b.007 m2
11-14-93 lw/ :7



Legend:

STP Pocatello Sewage Treatment Plant

RM River Mile

○ Location of well sampled

FMC Property

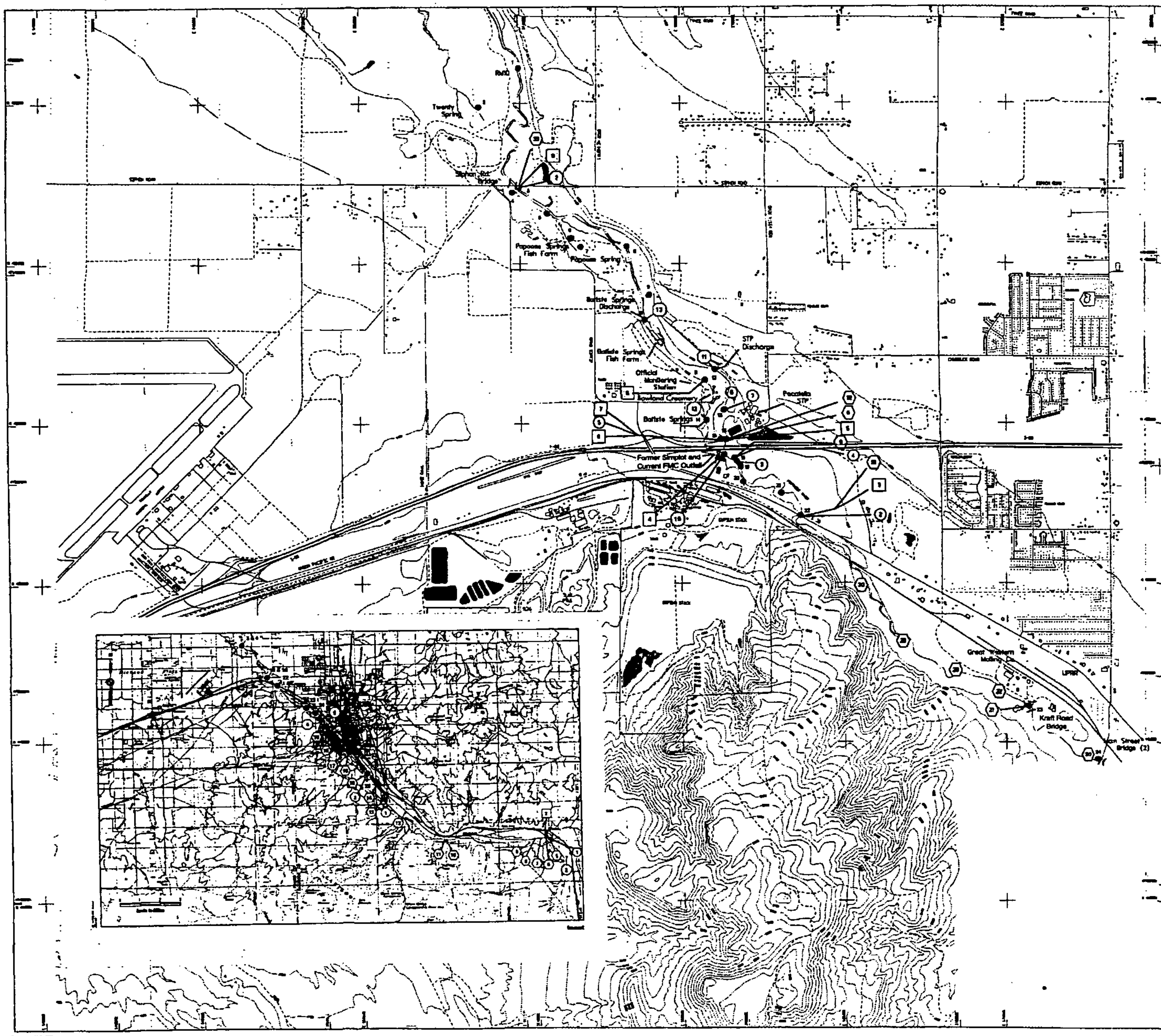
Simplot Property

0 1 2 miles

0 1 2 3 kilometers

95-1129b.005 m3
9-6-95 lw/rs :10

BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO		
EASTERN MICHAUD FLATS POCATELLO, IDAHO		
Location of Wells Sampled During Previous Investigations		
JOB No.	DRAWING NO.	REV.
21372	FIGURE 1.3-3	0



The Area Upstream from RI Sampling Location 24 is Shown in Inset at Left

Legend

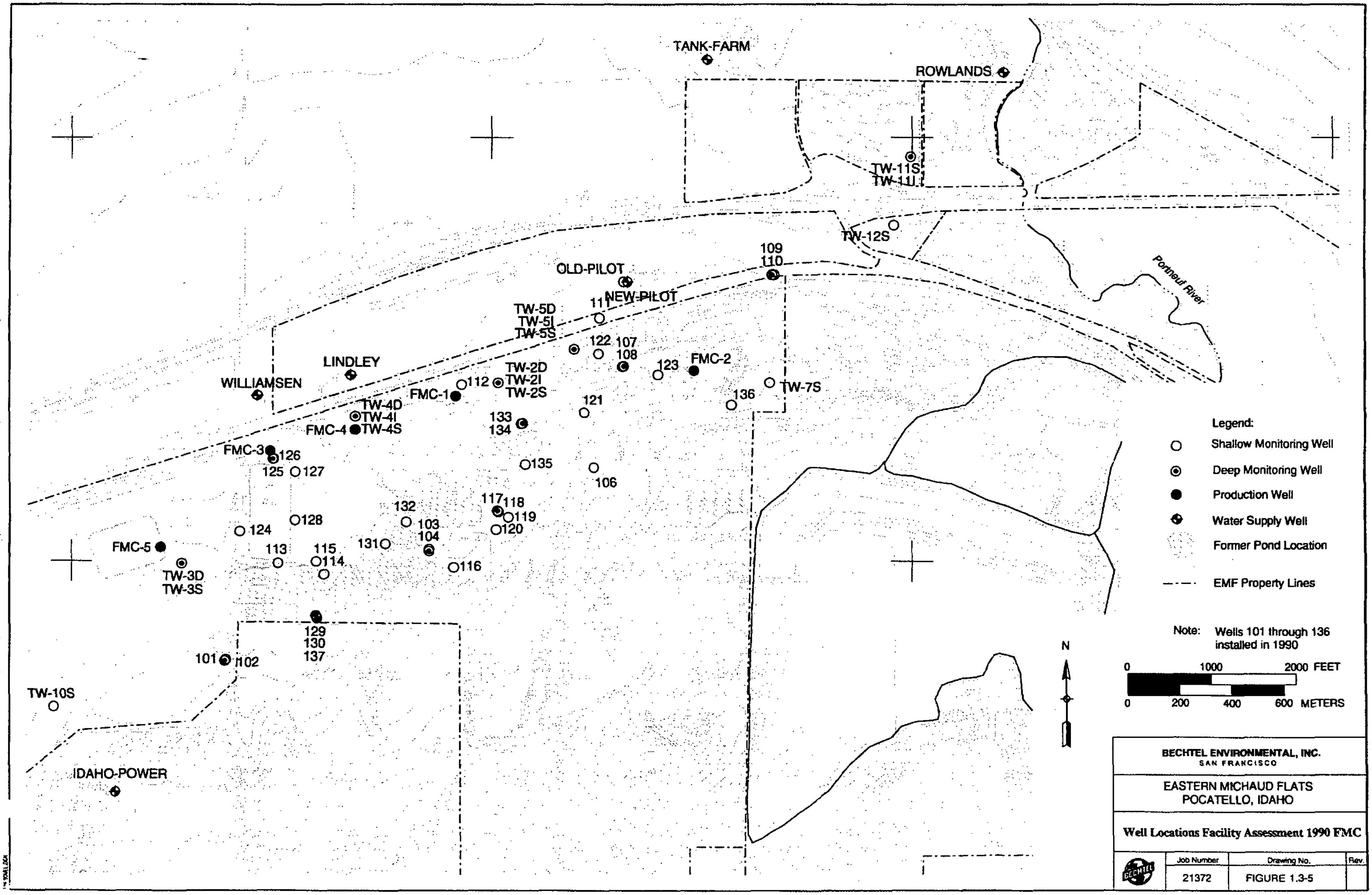
BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

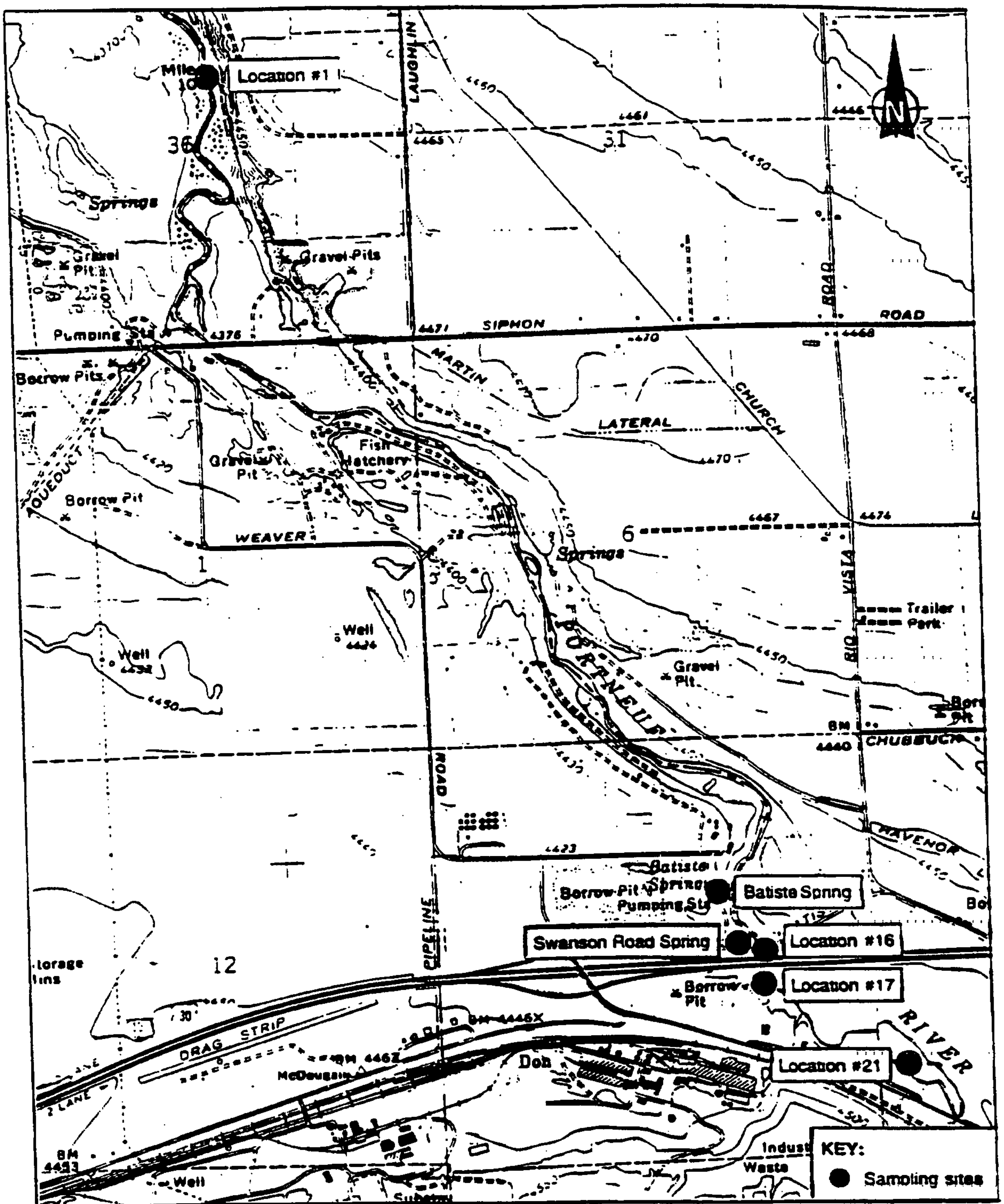
Locations of Surface Water and Sediment Points Used in Previous Investigations

21372	FIGURE 1.3-4	

Date 4/19/93



TANK-FARM
ROWLANDS
TW-11S
TW-11I
TW-12S
Portneuf River
109
110
OLD-PILOT
NEW-PILOT
111
TW-5D
TW-5I
TW-5S
122
107
108
123
FMC-2
TW-7S
136
LINDLEY
WILLIAMSEN
112
TW-2D
TW-2I
TW-2S
FMC-1
121
TW-4D
TW-4I
FMC-4
TW-4S
133
134
FMC-3
126
125
127
135
106
117
118
119
120
132
103
104
128
124
FMC-5
113
115
114
131
116
TW-3D
TW-3S
129
130
137
101
102
TW-10S
IDAHO-POWER
Legend:
Shallow Monitoring Well
Deep Monitoring Well
Production Well
Water Supply Well
Former Pond Location
EMF Property Lines
Note: Wells 101 through 136 installed in 1990
N
0 1000 2000 FEET
0 200 400 600 METERS
BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO
EASTERN MICHAUD FLATS
POCATELLO, IDAHO
Well Locations Facility Assessment 1990 FMC
Job Number
21372
Drawing No.
FIGURE 1.3-5
Rev.



SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Michaud, ID. 1971.

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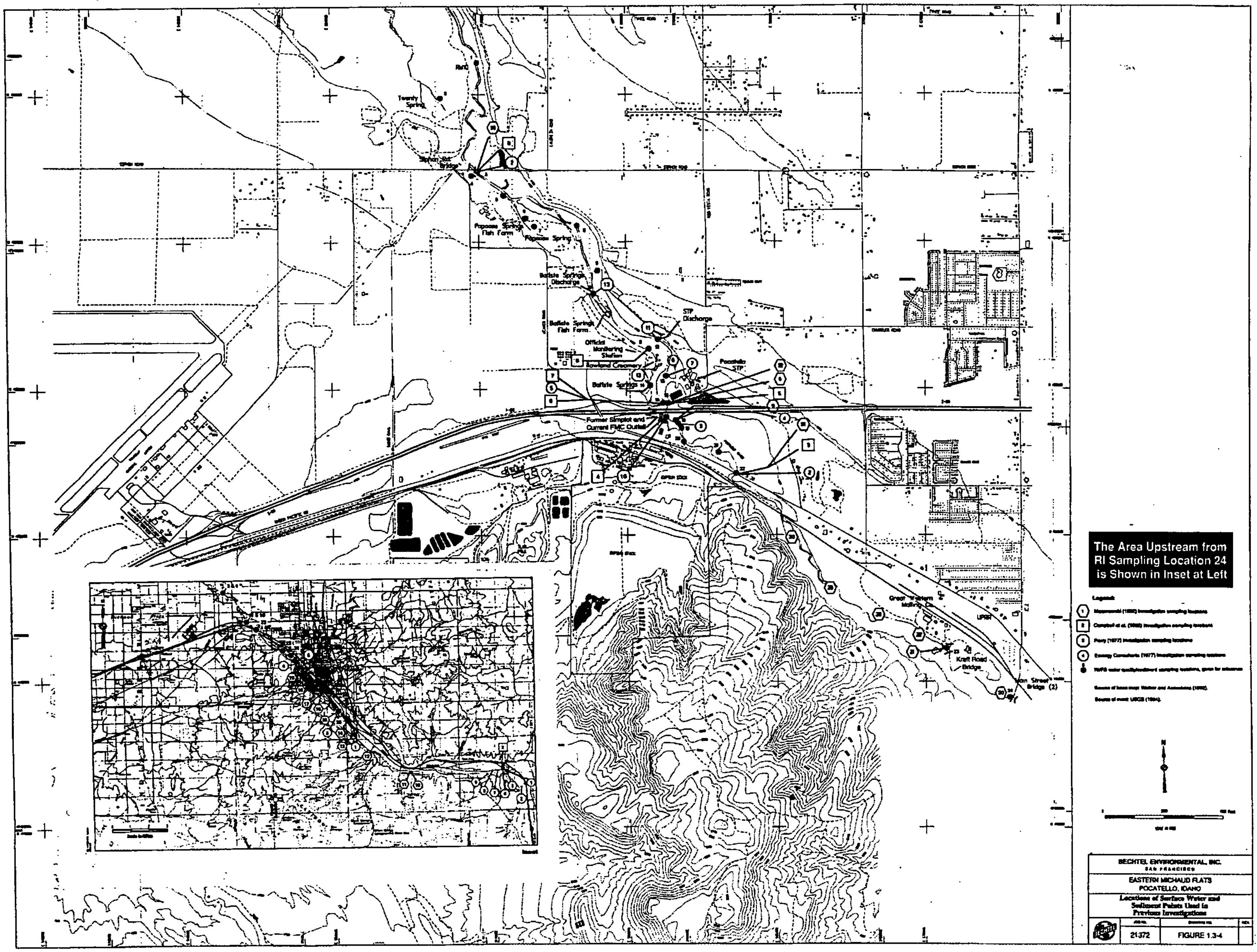
SCALE 1:24,000

0 ½ 1 Mile

0 .5 1 Kilometer

Figure 2.7-1 PORTNEUF RIVER SAMPLING STATIONS

Previous Inv.



Date 4/19/93